Office of
Fissile Materials Disposition

United States Department of Energy

Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement

Summary

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ABSTRACT: This document analyzes the potential environmental consequences of alternatives for the long-term storage (up to 50 years), including storage until disposition, and disposition of weapons-usable fissile materials from U.S. nuclear weapon dismantlements under the responsibility of the DOE. Long-term storage of nonsurplus inventories of weapons-usable plutonium (Pu) and highly enriched uranium (HEU) are required for national defense purposes, while the disposition of surplus weapons-usable Pu is necessary in order to implement our national nonproliferation policy. In addition to the No Action Alternative, this PEIS assesses three storage alternatives (that is, upgrade at multiple sites, consolidation of Pu, and collocation of Pu and HEU) at six DOE candidate sites located across the country. These sites are Hanford Site, Nevada Test Site, Idaho National Engineering Laboratory, Pantex Plant, Oak Ridge Reservation, and Savannah River Site. Although they are not candidate sites for storage, Rocky Flats Environmental Technology Site (RFETS) and Los Alamos National Laboratory are assessed for the No Action Alternative. For the disposition of surplus Pu, three alternative categories (that is, deep borehole, immobilization, and reactor) with nine primary alternatives are assessed at several DOE and representative sites for analysis purposes. Evaluations of impacts on site infrastructure, water resources, air quality and noise, socioeconomics, waste management, public and occupational health and safety, and environmental justice are included in the assessment. The intersite transportation of nuclear and hazardous materials is also assessed. DOE's Preferred Alternative is identified in this Final PEIS. The Preferred Alternative for storage is a combination of No Action and Upgrade Alternatives for the various DOE sites, and phaseout of Pu storage at RFETS. The Preferred Alternative for disposition of surplus Pu is to pursue a disposition strategy involving a combination of immobilization and reactor alternatives, including vitrification, ceramic immobilization, and existing reactors.

PUBLIC INVOLVEMENT: The DOE issued a Draft PEIS on March 8, 1996, and held a formal public comment period on the Draft through June 7, 1996. In preparing the Final PEIS, DOE considered comments received via mail, fax, electronic bulletin board (Internet), and transcripts of messages recorded by telephone. In addition, comments and concerns were recorded by notetakers during interactive public meetings held during March and April 1996 in Denver, CO, Las Vegas, NV, Oak Ridge, TN, Richland, WA, Idaho Falls, ID, Washington, DC, Amarillo, TX, and North Augusta, SC. Comments received and DOE's responses to those comments are found in Volume IV of the Final PEIS.

FOREWORD

This Summary of the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (PEIS) contains revisions and changes from the Draft PEIS Summary in response to comments, and information regarding the Department's Preferred Alternative. The Draft PEIS Summary has also been reorganized to provide a clear description of the environmental impacts of the Preferred Alternative and the comparison of storage and disposition alternatives including the Preferred Alternative.

The bar charts used in the Draft PEIS Summary to show impacts of various resources have been removed and replaced with narrative descriptions including pertinent data. New sections have been added to present the environmental impacts and cumulative impacts of the Preferred Alternative. Finally, a summary of major issues identified during the comment period and changes to the Draft PEIS is provided. Changes to the Draft PEIS Summary are denoted by sidebars (vertical lines adjacent to the text) in this Final PEIS Summary to facilitate review by the reader.

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LIST OF ACRONYMS AND ABBREVIATIONS

ANL-W	Argonne National Laboratory-West
APSF	Actinide Packaging and Storage Facility
ARIES	Advanced Recovery and Integrated Extraction System
BWR	boiling water reactor
CANDU	Canadian Deuterium Uranium
DNFSB	Defense Nuclear Facilities Safety Board
DoD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
DWPF	Defense Waste Processing Facility
EIS	environmental impact statement
ESA	*Endangered Species Act*
ES&H	environmental, safety, and health
FFTF	Fast Flux Test Facility
FMF	Fuel Manufacturing Facility
FONSI	Finding of No Significant Impact
GBZ	glass-bonded zeolite
Hanford	Hanford Site
HEU	highly enriched uranium
HEU EIS	*Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement*
HLW	high-level waste
ICPP	Idaho Chemical Processing Plant
IMNM EIS	*Environmental Impact Statement, Interim Management of Nuclear Materials*
INEL	Idaho National Engineering Laboratory
LANL	Los Alamos National Laboratory
LLNL	Lawrence Livermore National Laboratory
LLW	low-level waste
LWR	light water reactor
MEI	maximally exposed individual
MOX	mixed oxide
NEPA	*National Environmental Policy Act* of 1969
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System

NRHP	National Register of Historic Places
NTS	Nevada Test Site
NWPA	*Nuclear Waste Policy Act*
ORR	Oak Ridge Reservation
Pantex	Pantex Plant
PEIS	programmatic environmental impact statement
PFP	Plutonium Finishing Plant
PRA	Probabilistic Risk Assessment
PSD	Prevention of Significant Deterioration
PWR	pressurized water reactor
R&D	Research and Development
RCRA	*Resource Conservation and Recovery Act*
REA	regional economic area
RFETS	Rocky Flats Environmental Technology Site
ROD	Record of Decision
ROI	region of influence
RWMC	Radioactive Waste Management Complex
RWMS	Radioactive Waste Management Site
SRS	Savannah River Site
Stockpile Stewardship and Management PEIS	*Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management*
Storage and Disposition PEIS	*Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement*
TRU	transuranic
TSP	total suspended particulates
TSR PEIS	*Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling*
VRM	Visual Resource Management
WIPP	Waste Isolation Pilot Plant
WSA	Weapons Storage Area
Y–12	Y–12 Plant
Y–12 EA	*Environmental Assessment for the Proposed Interim Storage of Highly Enriched Uranium Above the Maximum Historical Storage Level at the Y-12 Plant*
ZPPR	Zero Power Physics Reactor

Chemicals and Units of Measure

cm	centimeter
Cs	cesium
Cs-137	cesium-137
CsCl	cesium chloride
gal	gallon
ha	hectare
H_2O	hydrogen oxide, or (light) water
in	inch
kg	kilogram
km	kilometer
l	liter
lb	pound
m^3	cubic meter
mi	mile
MLY	million liters per year
mrem	millirems
PM_{10}	particulate matter less than or equal to 10 microns in diameter
Pu	plutonium
Pu-238	plutonium-238
Pu-242	plutonium-242
PuO_2	plutonium dioxide
t	metric ton
tons	short tons
UO_2	uranium dioxide
yd^3	cubic yards
yr	year

Chemicals and Units of Measure

cm	centimeter
Cs	cesium
Cs-137	cesium-137
CsCl	cesium chloride
gal	gallon
ha	hectare
H_2O	hydrogen oxide, or (light) water
in	inch
kg	kilogram
km	kilometer
l	liter
lb	pound
m^3	cubic meter
mi	mile
MLY	million liters per year
mrem	millirems
PM_{10}	particulate matter less than or equal to 10 microns in diameter
Pu	plutonium
Pu-238	plutonium-238
Pu-242	plutonium-242
PuO_2	plutonium dioxide
t	metric ton
tons	short tons
UO_2	uranium dioxide
yd^3	cubic yards
yr	year

Metric Conversion Chart

To Convert Into Metric			To Convert Out of Metric		
If You Know	**Multiply By**	**To Get**	**If You Know**	**Multiply By**	**To Get**
Length					
inches	2.54	centimeters	centimeters	0.3937	inches
feet	30.48	centimeters	centimeters	0.0328	feet
feet	0.3048	meters	meters	3.281	feet
yards	0.9144	meters	meters	1.0936	yards
miles	1.60934	kilometers	kilometers	0.6214	miles
Area					
sq. inches	6.4516	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.092903	sq. meters	sq. meters	10.7639	sq. feet
sq. yards	0.8361	sq. meters	sq. meters	1.196	sq. yards
acres	0.40469	hectares	hectares	2.471	acres
sq. miles	2.58999	sq. kilometers	sq. kilometers	0.3861	sq. miles
Volume					
fluid ounces	29.574	milliliters	milliliters	0.0338	fluid ounces
gallons	3.7854	liters	liters	0.26417	gallons
cubic feet	0.028317	cubic meters	cubic meters	35.315	cubic feet
cubic yards	0.76455	cubic meters	cubic meters	1.308	cubic yards
Weight					
ounces	28.3495	grams	grams	0.03527	ounces
pounds	0.45360	kilograms	kilograms	2.2046	pounds
short tons	0.90718	metric tons	metric tons	1.1023	short tons
Temperature					
Fahrenheit	Subtract 32 then multiply by 5/9ths	Celsius	Celsius	Multiply by 9/5ths, then add 32	Fahrenheit

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}
hecto-	h	100 = 10^{2}
deka-	da	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}
femto-	f	0.000 000 000 000 001 = 10^{-15}
atto-	a	0.000 000 000 000 000 001 = 10^{-18}

Summary

S.1 INTRODUCTION

The end of the Cold War created a legacy of weapons-usable fissile materials both in the United States and the former Soviet Union. Substantial quantities of these materials, including plutonium (Pu) and highly enriched uranium (HEU), are no longer needed for defense purposes. Further agreements on disarmament between the United States and Russia may increase the surplus quantities of these materials. The global stockpiles of weapons-usable fissile materials pose a danger to national and international security in the form of potential proliferation of nuclear weapons and potential environmental, safety, and health consequences if the materials are not properly safeguarded and managed.

In September 1993, President Clinton issued the *Nonproliferation and Export Control Policy* in response to the growing threat of nuclear weapons proliferation. Further, in January 1994, President Clinton and Russia's President Yeltsin issued a *Joint Statement Between the United States and Russia on Nonproliferation of Weapons of Mass Destruction and Means of their Delivery*. In accordance with these policies, the focus of the U.S. nonproliferation efforts in this regard is five-fold: to secure nuclear materials in the former Soviet Union; to ensure safe, secure, long-term storage and disposition of surplus fissile materials; to establish transparent and irreversible nuclear reductions; to strengthen the nuclear nonproliferation regime; and to control nuclear exports.

To demonstrate the U.S. commitment to these objectives, the President announced on March 1, 1995, that 200 metric tons (t) (220 short tons [tons]) of U.S. fissile materials, 38.2 t (42.1 tons) of which is weapons-grade Pu (as stated in the Department of Energy's [DOE's] Openness Initiative of February 6, 1996), had been declared surplus to the U.S. nuclear defense needs. The United States is proceeding with plans and actions to ensure the continued safe, secure, and environmentally sound storage of its own weapons-usable fissile materials and is cooperating with Russia in an effort to reduce the risk of nuclear weapons proliferation. Additionally, DOE and its national laboratories have recently completed a joint study with Russia on technical options for the disposition of weapons-usable Pu.

> *Weapons-Usable Fissile Materials*
> *(Covered in the Programmatic Environmental Impact Statement)*
>
> All isotopes of Pu (except plutonium-238 [Pu-238]) and HEU that contain at least 20 percent uranium-235.[1]

A key element of DOE's decisionmaking is a thorough understanding of the environmental impacts that may occur during the implementation of the proposed action. The *National Environmental Policy Act* of 1969 (NEPA), as amended, requires Federal agencies to prepare an environmental impact statement (EIS) on all major Federal actions significantly affecting the quality of the human environment. In following this process, DOE has prepared the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (Storage and Disposition PEIS) to analyze various storage and disposition alternatives and to provide the necessary background, data, and analyses to help decisionmakers and the public understand the potential environmental impacts of each alternative. The results of the environmental analyses, together with information from technical and economic studies, nonproliferation analysis, and public input, will form the basis for DOE's decisions, which will be given in a Record of Decision (ROD) to be issued no sooner than

[1] Does not include spent nuclear fuel, irradiated targets, uranium-233, or Department of Defense (DoD) weapons program material in use.

30 days after publication of the Environmental Protection Agency's Notice of Availability of the Final PEIS. This process will also provide the United States with the basis and flexibility to implement Pu disposition efforts either multilaterally or bilaterally through negotiations or unilaterally as an example to Russia and other nations.

THE PROPOSED ACTION

The Department proposes to take the following actions for U.S. weapons-usable fissile materials:

- Storage—provide a long-term storage system (for up to 50 years) for nonsurplus Pu and HEU that meets the Stored Weapons Standard[2] and applicable environmental, safety, and health standards while reducing storage and infrastructure[3] costs

> *Stored Weapons Standard*
>
> The high standards of security and accounting for the storage of intact nuclear weapons should be maintained, to the extent practical, for weapons-usable fissile materials throughout dismantlement, storage, and disposition.

- Storage Pending Disposition—provide storage that meets the Stored Weapons Standard for inventories of weapons-usable Pu and HEU[4] that have been or may be declared surplus
- Disposition[5]—convert surplus Pu and Pu that may be declared surplus in the future to forms that meet the Spent Fuel Standard,[2] thereby providing evidence of irreversible disarmament and setting a model for proliferation resistance

> *Spent Fuel Standard*
>
> The surplus weapons-usable Pu should be made as inaccessible and unattractive for weapons use as the much larger and growing quantity of Pu that exists in spent nuclear fuel from commercial power reactors.

The Department's inventories of Pu and HEU are located at a number of DOE sites, including Hanford Site (Hanford), Idaho National Engineering Laboratory (INEL), Lawrence Livermore National Laboratory (LLNL), Los Alamos National Laboratory (LANL), Oak Ridge Reservation (ORR), Pantex Plant (Pantex), Rocky Flats Environmental Technology Site (RFETS), and Savannah River Site (SRS). These weapons-usable fissile materials are divided into two categories: surplus and nonsurplus. Surplus materials include those the President

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[2] Modified from *Management and Disposition of Excess Weapons Plutonium*, National Academy of Sciences, 1994.

[3] Includes electrical power, fuel, transportation network requirements, and safeguards/security.

[4] The Storage and Disposition PEIS covers long-term storage of nonsurplus HEU and storage of surplus HEU pending disposition. Until storage decisions are implemented, surplus HEU that has not gone to disposition will continue to be stored pursuant to, and not to exceed the 10-year interim storage time period evaluated in the *Environmental Assessment for the Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Storage Level at the Y-12 Plant, Oak Ridge, Tennessee* (Y-12 EA) (DOE/EA-0929, September 1994) and Finding of No Significant Impact (FONSI).

[5] Disposition of surplus HEU is addressed in a separate document, the *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement* (DOE/EIS-0240, June 1996).

has declared surplus to national defense needs in response to recommendations from the Nuclear Weapons Council (made up of representatives from DOE, the DoD, and the Joint Chiefs of Staff) and those that may be declared surplus in the future. The nonsurplus materials include naval nuclear fuel, strategic reserves, programmatic materials (non-weapons research and development [R&D], weapons R&D, and other programmatic materials), and weapons program materials in use, as shown in Figure S.1–1. Weapons program materials in use are not within the scope of the PEIS. The forms of the weapons-usable fissile materials are primarily pits and secondaries (weapons components bearing Pu and HEU, respectively) and metals and oxides of Pu and HEU.

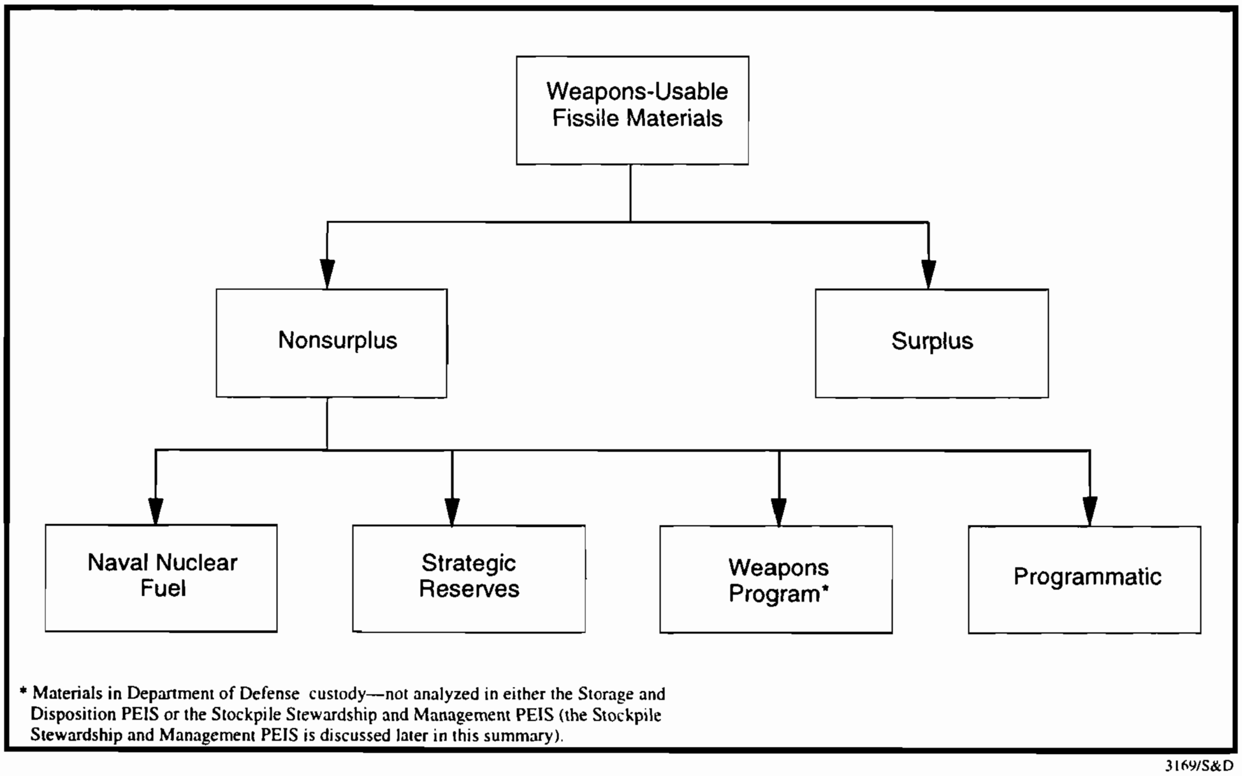

Figure S.1–1. Weapons-Usable Fissile Material Categories.

Purpose of and Need for the Proposed Action

The purpose of the proposed action is to implement the President's *Nonproliferation and Export Control Policy* in a safe, reliable, cost-effective, and timely manner. DOE is proposing a comprehensive program to accomplish this purpose by providing an exemplary long-term storage system for weapons-usable fissile materials, eliminating the stockpile of surplus weapons-usable Pu, and establishing the technical and program infrastructure that will provide for disposition of the surplus weapons-usable Pu in the United States.

The weapons-usable fissile materials declared surplus by the President (March 1995) are in various compositions and forms. A storage plan is needed to provide continued adequate control of these surplus materials and any that may be declared surplus in the future, from now through final disposition, as well as management and long-term storage of nonsurplus fissile materials that will not be subject to disposition. Approximately 89 t (98 tons) of Pu (reported in DOE's Openness Initiative on December 7, 1993) and 994 t (1,095 tons) of HEU (reported in DOE's Openness Initiative on June 29, 1994) were produced by the United States during the period its production facilities were in operation. Some of these materials have been used in weapons or for other programmatic purposes, some of the remainder have been declared surplus, and additional materials could be declared surplus in the future. Disposition of surplus Pu is needed to reduce reliance on institutional controls and to provide visible evidence of irreversible disarmament. Therefore, a comprehensive long-term storage and disposition action is needed to ensure that weapons-usable fissile materials are properly managed and to prevent the potential increase of environmental, safety, and health risks. DOE also recognizes the need to strengthen national and international arms control efforts by providing a storage and disposition model for the international community. This action will enhance U.S. credibility and flexibility in negotiations on bilateral or multilateral reductions of surplus weapons-usable fissile material inventories.

SCOPE OF THE PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

The Storage and Disposition PEIS analyzes the direct, indirect, and cumulative environmental effects of reasonable alternatives for the long-term storage of nonsurplus Pu and HEU, the storage of surplus Pu and HEU pending disposition, and the disposition of surplus Pu. A separate DOE document, *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement* (HEU EIS), addresses the disposition of surplus HEU. The HEU EIS (DOE/EIS-0240) was issued in June 1996, and the ROD published on August 5, 1996.

The Storage and Disposition PEIS includes analyses of storing 89 t (98 tons) of Pu and 994 t (1,093 tons) of HEU (reported in DOE's Openness Initiative referenced above). The PEIS also analyzes the disposition of a nominal 50 t (55.1 tons) of Pu, including the 38.2 t (42.1 tons) of Pu that has been declared surplus as well as Pu that may be declared surplus in the future (although the exact quantity of Pu that may be declared surplus is not known at this time). The locations of the surplus material in the DOE complex are shown in Figures S.1–2 and S.1–3.

The Storage and Disposition PEIS assumes that the weapons-usable fissile material is in a stabilized form; the PEIS begins, as a starting point, after stabilization has been completed. DOE is currently in the process of stabilizing and repackaging weapons-usable fissile materials and placing them in safe, secure storage awaiting decisions on long-term storage and disposition. For Pu, this is being accomplished in accordance with the corrective actions identified in DOE's *Plutonium Vulnerability Management Plan* (DOE/EM-0199). This plan was developed in response to an assessment in DOE's *Plutonium Working Group Report* (DOE/EH-0415) and recommendations by the Defense Nuclear Facilities Safety Board (DNFSB) in DNFSB Recommendation 94-1. In addition, Pu materials will also meet the *Criteria for Safe Storage of Plutonium Metals and Oxides* (DOE-STD-3013-94), a DOE standard for long-term storage (at least 50 years) of these materials. Similarly, the HEU materials requiring long-term storage will meet criteria for safe storage of HEU metals and oxides; these criteria are under development at this time. Appropriate environmental documentation will be prepared, as necessary, for stabilizing and repackaging the Pu and HEU materials to meet respective long-term storage criteria.

Following the discontinuance of nuclear weapons material production, large quantities of residues remained as a result of the chemical and thermal processes used to separate and purify Pu. Examples of residue forms include some impure oxides and metals, halide salts, combustibles, ash, sludges, and contaminated glass. To meet requirements of DOE's *Plutonium Vulnerability Management Plan,* as well as various compliance agreements with State and local regulatory agencies, some Pu residues must be stabilized. As a result of the stabilization process, portions of the residues will potentially be concentrated and stored. These concentrates may be in a form and concentration (greater than 50 percent Pu by weight) that is weapons-usable and are therefore included in the PEIS.[6]

The Storage and Disposition PEIS pertains to weapons-usable fissile materials that meet all of the standards and criteria previously described. Fissile materials present in spent nuclear fuel or irradiated targets from reactors

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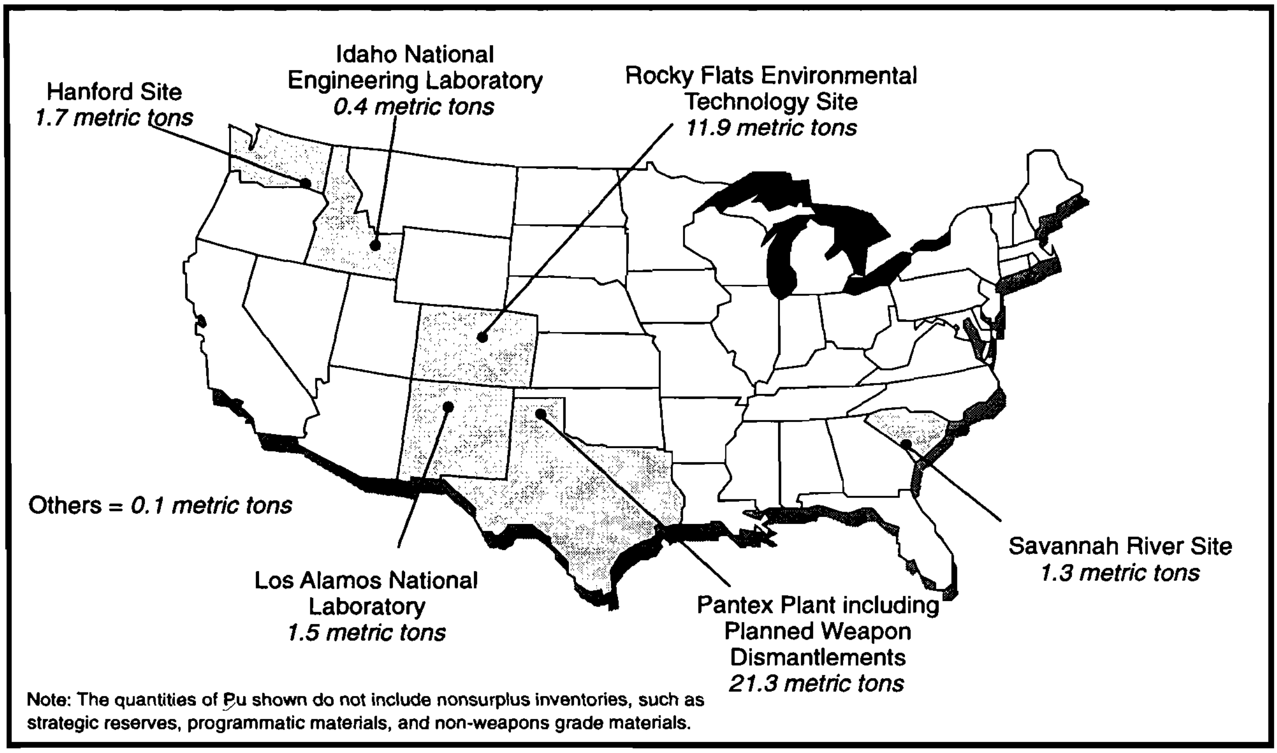
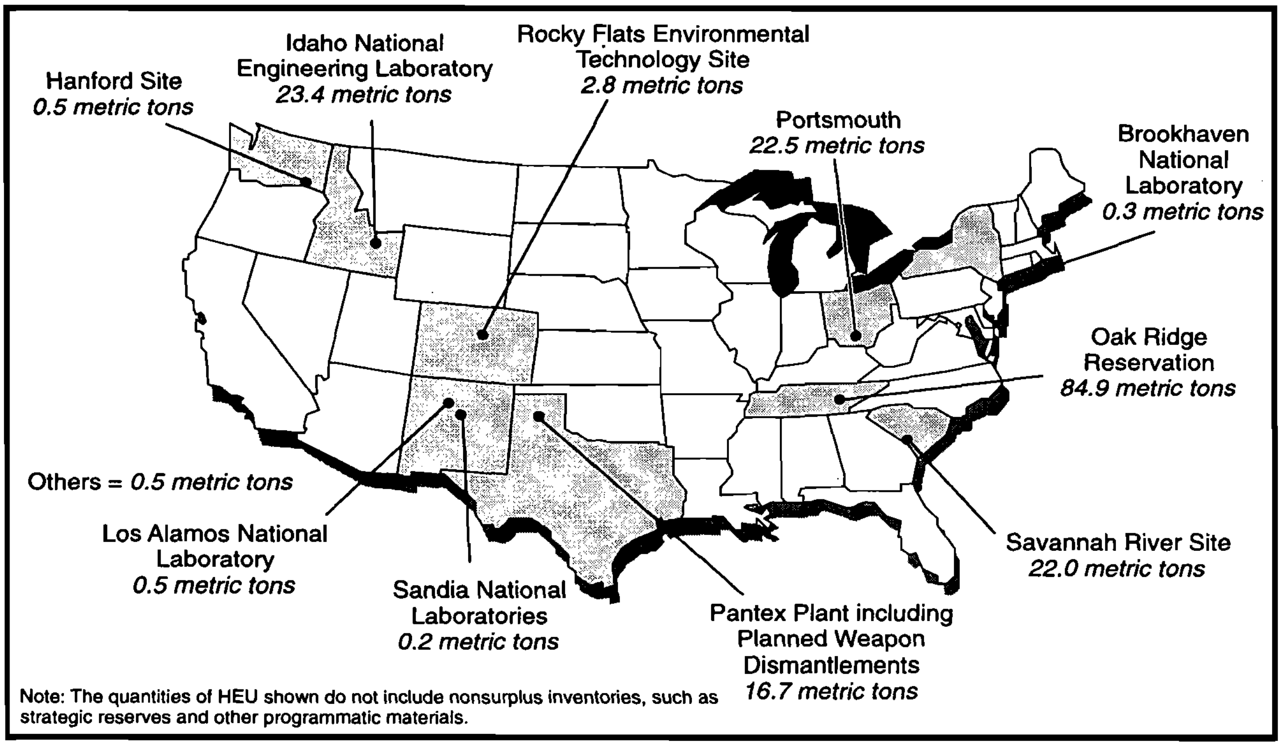
[6] As a result of the stabilization process, there will also be non-weapons-usable Pu or HEU contaminated wastes or residues (less than 50 percent Pu by weight) that would not be within the scope of the PEIS. On November 19, 1996, DOE announced its intention to prepare an EIS on the *Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site* (61 FR 58866). This EIS will evaluate the potential environmental impacts associated with reasonable management alternatives for certain Pu residues and all scrub alloy currently stored at RFETS.



2679/FMD

Figure S.1–2. Department of Energy Locations With Surplus Weapons-Grade Plutonium Inventories in September 1994.



2680/FMD

Figure S.1–3. Department of Energy Locations With Surplus Highly Enriched Uranium Inventories on February 6, 1996.

are not covered in the PEIS; they are not considered weapons-usable because separation of the relevant isotopes from these highly radioactive materials requires significant remote chemical processing. Reprocessing and extraction of Pu from spent fuel is not proposed, and is beyond the scope and the fundamental nonproliferation purpose of the program covered by the PEIS.

DECISIONS TO BE MADE

The Storage and Disposition Draft PEIS was circulated for public review and comment from March 8 through June 7, 1996. Eight public meetings in the vicinity of DOE sites under consideration for the Proposed Action, and in Washington, DC, were held during the comment period. Approximately 8,700 comments were received from other Federal government agencies, State and local governments, Native American tribes, special interest groups, and the public. These comments, along with DOE's responses, became a part of the Final PEIS. DOE also made available for public review, the results of the technical, cost and schedule analyses in July and October 1996, as well as the nonproliferation analysis in November 1996. Along with the PEIS, these analyses will support a formal ROD regarding Pu and HEU storage and surplus Pu disposition. [Text deleted.] These decisions are as follows:

For storage:

- The strategy for long-term storage of nonsurplus weapons-usable Pu and nonsurplus HEU
- The strategy for storage of surplus Pu and surplus HEU pending disposition
- The storage site(s) and (if appropriate) facilities

For disposition:

- The strategy and technologies for disposition of surplus weapons-usable Pu

The Department, with interagency coordination, will then issue the ROD. Following the ROD, subsequent tiered and project-specific NEPA documents will be prepared. The tiered NEPA reviews will analyze alternative locations for disposition activities.

Plutonium Immobilization

A process that converts Pu to a chemically stable form for disposition. The forms analyzed in the PEIS include glass (through vitrification), ceramic (through ceramic immobilization), and glass-bonded zeolite (through electrometallurgical treatment).

Mixed Oxide Fuel

A blend of uranium dioxide [UO_2] and plutonium dioxide [PuO_2] that produces a fuel suitable for use in a nuclear reactor to generate electric power.

> *Light Water Reactor*
>
> A nuclear reactor in which circulating water consisting of light water (hydrogen oxide [H_2O]) is used to cool the reactor core and reduce the energy of neutrons created in the core by fission reactions. All commercial reactors in the United States are LWRs.

> *Canadian Deuterium Uranium Reactor*
>
> A Canadian nuclear reactor in which the circulating water consists of heavy water (deuterium oxide). Deuterium is an isotope of hydrogen having twice the mass of hydrogen. All commercial reactors in Canada are heavy water reactors.

S.2 PREFERRED ALTERNATIVE

STORAGE

The Department's Preferred Alternative for storage is to reduce, over time, the number of locations where the various forms of Pu are stored, through a combination of storage alternatives in conjunction with a combination of disposition alternatives. DOE would begin implementing this Preferred Alternative by moving surplus Pu from RFETS as soon as possible, transporting the pits to Pantex as early as 1997, and the non-pit Pu materials to SRS beginning in 2002. Over time, DOE would store Pu in upgraded facilities at Pantex and in an expanded, planned new facility at SRS, and store nonsurplus HEU and surplus HEU pending disposition in upgraded and consolidated facilities at ORR. Storage facilities would also be modified, as needed, to accommodate international inspection requirements consistent with the President's *Nonproliferation and Export Control Policy*. Accordingly, DOE's Preferred Alternative for storage would call for the following actions:

- **Phase out storage of all weapons-usable Pu at RFETS beginning in 1997; move pits to Pantex, and non-pit materials to SRS.** At Pantex, DOE would repackage pits from RFETS in Zone 12, then place them in existing storage facilities in Zone 4, pending completion of facility upgrades in Zone 12. At SRS, DOE would expand the planned new Actinide Packaging and Storage Facility (APSF), and move non-pit Pu materials from RFETS, after stabilization at RFETS, to the expanded APSF upon completion. The small number of pits currently at RFETS that are not in shippable form would be placed in a shippable condition in accordance with existing procedures prior to shipment to Pantex. Additionally, some pits and non-pit Pu materials from RFETS could be used at SRS, LANL, and LLNL for tests and demonstrations of aspects of disposition technologies (see Preferred Alternative for disposition as discussed later in this section). All non-pit weapons-usable Pu materials currently stored at RFETS are surplus.

- **Upgrade storage facilities at Zone 12 South (to be completed by 2004) at Pantex to store those pits currently stored at Pantex, and pits from RFETS, pending disposition. Storage facilities at Zone 4 would continue to be used for these pits prior to completion of the upgrade.** This action would place pits at a central location where most pits already reside and where expertise and infrastructure exist to accommodate pit storage.

- **In accordance with the Preferred Alternative in the *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (Stockpile Stewardship and Management PEIS), store Strategic Reserve pits at Pantex in the facilities discussed above. To the extent not reflected above, store Strategic Reserve materials in accordance with the Preferred Alternative in the Stockpile Stewardship and Management PEIS.**

- **Expand the APSF (Upgrade Alternative) at SRS to store those surplus, non-pit Pu materials currently at SRS and surplus non-pit Pu materials from RFETS, pending disposition** (see Preferred Alternative for disposition as discussed later in this section). The APSF would be built by 2001 pursuant to the *Final Environmental Impact Statement, Interim Management of Nuclear Materials* (IMNM EIS) (DOE/EIS-0220) and ROD, and the expansion to accommodate RFETS material would be completed by 2002. The RFETS surplus non-pit Pu materials would be moved to SRS after stabilization is performed at RFETS under corrective actions in response to recommendation 94-1 by the DNFSB, and after completion of the APSF expansion. This action would place non-pit Pu materials in a new storage facility, in a location with existing expertise and Pu handling capabilities and where potential disposition activities could occur (see Preferred Alternative for disposition as discussed later in this section). Strategic pits currently located at SRS would be stored in accordance with the Preferred Alternative in the Stockpile Stewardship and Management PEIS. There are no strategic non-pit materials currently located at SRS.

- **Continue current storage (No Action) of surplus Pu at Hanford and INEL, pending disposition** (or movement to lag storage[7] at the disposition facilities). This action would allow surplus Pu to remain at the sites with existing expertise and Pu handling capabilities, and where potential disposition activities could occur (see Preferred Alternative for disposition as discussed later in this section). There are no nonsurplus weapons-usable Pu materials currently stored at either site.

- **Continue current storage (No Action) of surplus Pu at LANL, pending disposition** (or movement to lag storage at the disposition facilities). This Pu would be stored in stabilized form with the nonsurplus Pu in the upgraded Nuclear Material Storage Facility pursuant to the No Action Alternative for the site.

- **Take No Action at the Nevada Test Site (NTS).** DOE would not add Pu to sites that do not currently have Pu in storage.

- **Upgrade storage facilities at the Y–12 Plant (Y–12) (to be completed by 2004, or earlier) at ORR to store nonsurplus HEU and surplus HEU pending disposition.** Existing storage facilities at Y–12 would be modified to meet natural phenomena requirements, as documented in *Natural Phenomena Upgrade of the Downsized/Consolidated Oak Ridge Uranium/Lithium Plant Facilities* (Y/EN-5080, 1994). Storage facilities would be consolidated and the storage footprint would be reduced as surplus HEU is dispositioned and blended to low-enriched uranium, pursuant to the HEU EIS. Consistent with the Preferred Alternative in the Stockpile Stewardship and Management PEIS, HEU strategic reserves would be stored at the Y–12 Plant.

DISPOSITION

The Department's Preferred Alternative for the disposition of surplus Pu is to pursue a disposition strategy that allows for immobilization of surplus weapons Pu in glass or ceramic forms and burning of the surplus Pu as mixed oxide (MOX) fuel in existing reactors. The disposition of the surplus Pu using these technological approaches would depend on the results of future technology development and demonstrations, site-specific environmental analyses, and detailed cost proposals as well as nonproliferation considerations. The results of

[7] Lag storage is temporary storage at the applicable disposition facility.

these efforts and negotiations with Russia and other nations will ultimately determine the timing and extent to which either or both technologies are deployed.[8]

Under this Preferred Alternative, the U.S. policy not to encourage the civil use of Pu and, accordingly, not to itself engage in Pu reprocessing for either nuclear power or nuclear explosive purposes will not change. Although under the Preferred Alternative some Pu may ultimately be burned in existing reactors, every possible means will be pursued to ensure that Federal support for this unique disposition mission does not encourage other civil uses of Pu or Pu reprocessing. The United States, however, will maintain its commitments regarding the use of Pu in civil nuclear programs in Western Europe and Japan.

Proceeding with this strategy would provide increased flexibility to initiate Pu disposition promptly, and help assure disposition efforts could be accomplished in a timely manner. Establishing the means for expeditious Pu disposition would also help provide the basis for an international cooperative effort that can result in reciprocal, irreversible Pu disposition actions by Russia. DOE's preferred disposition strategy signals a strong U.S. commitment to reducing its stockpile of surplus Pu, thereby effectively meeting the purpose of and need for the Proposed Action.

To accomplish the Pu disposition mission, DOE would consider, to the extent practical, new as well as modified existing buildings and facilities for portions of the disposition activities. The PEIS analyzes new facilities for most disposition alternatives to obtain bounding environmental impacts. DOE would analyze and compare existing and new buildings and facilities for the technologies chosen as part of this strategy in subsequent, tiered NEPA review. In addition, all disposition facilities would be designed or modified, as needed, to accommodate international inspection requirements consistent with the President's *Nonproliferation and Export Control Policy*. Accordingly, DOE's Preferred Alternative for Pu disposition involves the following strategy and supporting actions:

- **Immobilize Pu materials using vitrification or ceramic immobilization.** The immobilization technology could be used for processing pure or impure forms of Pu. Vitrification or ceramic immobilization could include the can-in-canister variant, which could utilize the existing high-level wastes (HLW) and the Defense Waste Processing Facility (DWPF) at SRS, or new facilities at Hanford or SRS. DOE would continue the R&D leading to the demonstration of the can-in-canister variant at the DWPF using surplus Pu.

- **Convert Pu materials into MOX fuel for use in existing reactors.** Pure materials including pits, pure metal, and oxides could be converted without extensive processing into MOX fuel for use in existing commercial reactors. Other, already separated forms of surplus Pu would require additional cleanup (not reprocessing of spent nuclear fuel). The MOX fuel would be used in existing light water reactors (LWRs) with a once-through fuel cycle, with no reprocessing and subsequent reuse of the spent fuel. If partially completed LWRs were to be completed by other parties, they would be considered for this mission. The MOX fuel would be fabricated in a domestic, government-owned facility at a DOE site.

  The Department would retain using MOX fuel in Canadian Deuterium Uranium (CANDU) reactors in Canada in the event that a multilateral agreement to use CANDU reactors is negotiated among Russia, Canada, and the United States. DOE would engage in a test and demonstration for CANDU MOX fuel as appropriate and consistent with future cooperative efforts with Russia and Canada.

With regard to the above, for purposes of analysis of an approach involving a combination of both technologies, approximately 70 percent of the surplus Pu was identified to be in forms (metals and other pure forms) suitable

[8] Through these efforts, the President would be provided the basis and flexibility to initiate disposition efforts either multilaterally or bilaterally through negotiations or unilaterally as an example to Russia and other nations.

for MOX fuel. The actual percentage and timing for disposition of the surplus Pu using either or a combination of both of the technological approaches would depend on the results of international agreements, future technology development and demonstrations, site-specific environmental assessments, and detailed cost proposals to be completed within the next 2 years. The results of these efforts, as well as nonproliferation considerations and negotiations with Russia and other nations, will ultimately determine the timing and extent to which either or both technologies are deployed for disposition of surplus Pu. In the event both technologies are deployed, and because the time required for Pu disposition using reactors would be longer than that for immobilization, it is probable that some surplus Pu would be immobilized initially, prior to completion of reactor irradiation for other surplus Pu. Deployment of this strategy would involve the following supporting actions:

- **Constructing and operating a Pu vitrification or ceramic immobilization facility at either Hanford or SRS.** DOE would analyze alternative locations at these two sites for constructing new or potentially using modified existing buildings in subsequent tiered NEPA review. SRS has existing facilities and infrastructure to support an immobilization mission, and Hanford has existing plans for constructing and operating immobilization facilities for the wastes in Hanford tanks. DOE would not create new infrastructure for immobilizing Pu with HLW or cesium (Cs) at INEL, NTS, ORR, or Pantex.

- **Constructing and operating a Pu conversion facility[9] at either Hanford or SRS.** DOE would collocate the Pu conversion facility with the vitrification or ceramic immobilization facility discussed above. In subsequent, tiered NEPA reviews, DOE would analyze alternative locations at Hanford and SRS, for constructing new or potentially using modified existing buildings.

- **Constructing and operating a pit disassembly/conversion facility[10] at Hanford, INEL, Pantex, or SRS.** DOE would not add Pu to sites that do not currently have Pu in storage. Therefore, two sites analyzed in the PEIS, NTS and ORR, would not be considered further for Pu disposition activities. DOE would analyze alternative locations at Hanford, INEL, Pantex, and SRS for constructing new or potentially using modified existing buildings in subsequent tiered NEPA review. DOE would demonstrate the Advanced Recovery and Integrated Extraction System (ARIES) concept at LANL for pit disassembly/conversion beginning in fiscal year 1997.

- **Constructing and operating a domestic, government-owned, MOX fuel fabrication facility at Hanford, INEL, Pantex, or SRS.** DOE would not add Pu to sites that do not currently have Pu in storage. Therefore, two sites analyzed in the PEIS, NTS and ORR, would not be considered further for Pu disposition activities. The MOX fuel fabrication facility would serve only the finite mission of fabricating MOX fuel using surplus Pu for the purpose of Pu disposition. DOE would analyze alternative locations at Hanford, INEL, Pantex, and SRS, for constructing new or potentially using modified existing buildings in subsequent tiered NEPA review.

Depending upon decisions in the ROD and pursuant to appropriate NEPA review(s), DOE would continue R&D and engage in further testing and demonstrations of Pu disposition technologies which may include: dissolution of small quantities of Pu in both glass and ceramic formulation; experiments with immobilization equipment and systems; fabrication of MOX fuel pellets for demonstrations of reactor irradiation at INEL; mechanical milling and mixing of Pu and feed forms; and testing of shipping and storage containers for certification, in addition to the testing and demonstrations previously described for the can-in-canister immobilization variant

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[9] The Pu conversion facility would convert surplus non-pit Pu material (using a wet chemical process) into a metal or oxide form suitable for use at the next facility in the disposition process.

[10] The pit disassembly/conversion facility would dissemble, reshape, and convert surplus Pu pits (using a dry chemical process) into an unclassified metal or oxide form suitable for use at the next facility in the disposition process. In addition, some non-pit Pu material may also be processed in this facility.

and the ARIES. These tests and demonstrations would slightly reduce the quantity of RFETS pit and non-pit materials to be stored at Pantex and SRS, respectively.

The storage and disposition actions proposed for various DOE sites by the Preferred Alternative are summarized in Table S.2–1.

Table S.2–1. Storage and Disposition Actions Proposed by the Preferred Alternative

Action	Hanford	NTS	INEL	Pantex	ORR	SRS	RFETS	LANL
Storage								
No Action	X[a]	X[b]	X[a]					X[a]
Upgrade				X[c]	X[d]	X[e]		
Phaseout							X	
Disposition[f]								
Pit Disassembly/Conversion	X		X	X		X		
MOX Fuel Fabrication	X		X	X		X		
Pu Conversion	X					X		
Immobilization	X					X		

[a] Pending subsequent tiered NEPA decisions for disposition of surplus Pu.
[b] NTS does not currently store either Pu or HEU.
[c] For storage of those pits currently at Pantex and pits from RFETS.
[d] For storage of HEU only.
[e] For storage of only those Pu materials currently at SRS and non-pit Pu materials from RFETS.
[f] "X" denotes potential sites for locating the disposition facilities pending subsequent tiered NEPA decisions. Only one of each facility is needed for accomplishing the disposition mission.

S.3 DEVELOPMENT OF ALTERNATIVES

The Storage and Disposition PEIS analyzes a number of reasonable alternatives for storage and disposition in addition to the No Action Alternative. DOE used a screening process along with public input to identify a range of reasonable alternatives for the storage and disposition of weapons-usable fissile materials. The process was conducted by a screening committee that consisted of experts from DOE assisted by technical advisors from DOE's national laboratories and other support staff. The committee was responsible for identifying the reasonable alternatives to be evaluated. It compared alternatives against screening criteria, considered input from the public, and used technical reports and analyses from the national laboratories and industry to develop a final list of alternatives.

The first step in the screening process was to develop criteria against which to judge potential alternatives. The criteria were developed for the screening process based on the President's *Nonproliferation and Export Control Policy* of September 1993, the *Joint Statement Between the United States and Russia on Nonproliferation of Weapons of Mass Destruction and the Means of Their Delivery* of January 1994, and the analytical framework established by the National Academy of Sciences in its 1994 report, *Management and Disposition of Excess Weapons Plutonium*. The criteria include resistance to theft and diversion; resistance to retrieval and reuse; impact to environment, safety, and health (ES&H); public and institutional acceptance; timeliness and technological viability; cost-effectiveness; international cooperation; and additional benefits. The criteria were discussed at the public scoping workshops, and participants were invited to comment further using questionnaires. The questionnaires allowed participants to rank criteria based on relative importance, comment on the appropriateness of the criteria, and suggest new criteria. Details on how the screening process was developed and applied, and the results obtained from the process, were published in a separate report, the *Summary Report of the Screening Process* (DOE/MD-0002, March 1995). Figures S.3–1 and S.3–2 show the results of the screening process for the long-term storage and the disposition options, respectively, including the options that were selected as reasonable alternatives for analysis in the PEIS, the options that were disqualified and eliminated, and the reasons for disqualification and elimination (given in parentheses).[11]

STORAGE OPTIONS

NO ACTION	Baseline
UPGRADE EXISTING INTERIM STORAGE FACILITIES	Reasonable
CONSOLIDATE STORAGE AT DOE SITES	Reasonable
UTILIZE FACILITIES AT NON-DOE DOMESTIC SITES	Eliminated (Cost-Effectiveness, ES&H)
UTILIZE NON-DOMESTIC SITES	Disqualified (Higher Safeguard and Security Risks)

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Figure S.3–1. Results of the Screening Process—Long-Term Storage Options.

DEVELOPMENT OF LONG-TERM STORAGE ALTERNATIVES

For storage, DOE began with five potential alternatives (see Figure S.3–1), including the No Action Alternative. The screening process identified two action alternatives as reasonable: (1) upgrade storage facilities and (2) consolidate storage at DOE sites. The second alternative was later refined and converted into two alternatives: consolidate Pu storage at one site (while HEU storage remains at ORR), and collocation of Pu and HEU storage at one site. [Text deleted.] Subalternatives and options were also added (see discussions in next section). In addition, the Preferred Alternative for storage (discussed previously) was developed and reflects a combination of the Upgrade Alternative, sub-options, and the No Action Alternative.

To select candidate sites for long-term storage, DOE used a separate set of siting criteria consistent with those used in the evaluation of sites for reconfiguration of the Nuclear Weapons Complex in February 1991. The siting criteria included population; ES&H; socioeconomics; transportation; and site availability and flexibility. The process resulted in six candidate storage sites: Hanford, NTS, INEL, Pantex, ORR, and SRS.

Development of Long-Term Storage Subalternatives

With the exception of weapons program materials in use, the Storage and Disposition PEIS analyzes the environmental impacts of reasonable alternatives for long-term storage of all surplus and nonsurplus weapons-usable fissile material categories (see Figure S.1–1). In DOE's Stockpile Stewardship and Management PEIS, a portion of the nonsurplus weapons-usable fissile materials, namely the strategic reserve materials and the plutonium-242 (Pu-242) materials used for weapons R&D, is analyzed for long-term storage. The Preferred Alternative in the Stockpile Stewardship and Management PEIS is to move Pu-242 currently stored at SRS to LANL for long-term storage. The Storage and Disposition PEIS includes a subalternative analyzing the environmental effects of each long-term storage alternative without the strategic reserve materials and weapons R&D materials.[12] Preparation of these two documents is being closely coordinated to ensure that all necessary information is available to the decisionmaker. Preferred alternatives are being presented to the Secretary of Energy on both PEISs for the Secretary's decisions and the publication of the RODs.

Because of the cleanup agreement for RFETS, the proximity of RFETS to the Denver metropolitan area, and the fact that three out of the five most vulnerable facilities identified in DOE's *Plutonium Working Group Report on Environmental, Safety, and Health Vulnerabilities Associated With the Department's Plutonium Storage* (DOE/EH-0415, November 1994) are located at the site, RFETS is considered as a storage site only under the

[11] Following issuance of the screening report, two changes were made during subsequent meetings of the screening committee; that is, options I6 (glass material oxidation/dissolution system) and RI (Euratom MOX fuel fabrication/reactor burning) were eliminated.

[12] The Storage and Disposition PEIS also analyzes the "umbrella" option, for each storage alternative, of storing strategic reserves and weapons R&D material together with other nonsurplus material.

STORAGE OPTIONS

S1	NO DISPOSITION ACTION (CONTINUED STORAGE)	Baseline
S2	RADIATION BARRIER ALLOY (STORAGE)	Eliminated (Open-Ended, ES&H)

DIRECT DISPOSAL OPTIONS

D1	DIRECT EMPLACEMENT IN HLW REPOSITORY	Disqualified (Retrievability, Timeliness)
D2	DEEP BOREHOLE (IMMOBILIZATION)	Reasonable
D3	DEEP BOREHOLE (DIRECT EMPLACEMENT)	Reasonable
D4	DISCARD TO WASTE ISOLATION PILOT PLANT	Disqualified (Capacity)
D5	HYDRAULIC FRACTURING	Disqualified (Technical Viability)
D6	DEEP WELL INJECTION	Disqualified (ES&H)
D7	INJECTION INTO CONTINENTAL MAGMA	Eliminated (Technical Viability, ES&H)
D8	MELTING IN CRYSTALLINE ROCK	Disqualified (Technical Viability)
D9	DISPOSAL UNDER ICE CAPS	Disqualified (Technical Viability, ES&H)
D10	SEABED (PLACEMENT ON OCEAN FLOOR)	Disqualified (ES&H)
D11	SUB-SEABED EMPLACEMENT	Eliminated (Technical Viability)
D12	OCEAN DILUTION	Disqualified (ES&H)
D13	DEEP SPACE LAUNCH	Eliminated (Retrievability, ES&H)

IMMOBILIZATION OPTIONS (WITH RADIONUCLIDES)

I1	UNDERGROUND NUCLEAR DETONATION	Disqualified (ES&H, Licensing/Regulatory)
I2	BOROSILICATE GLASS IMMOBILIZATION (RETROFITTED DWPF)	Eliminated[a]
I3	VITRIFICATION (BOROSICLICATE GLASS IMMOBILIZATION [NEW FACILITY])	Reasonable
I4	CERAMIC IMMOBILIZATION	Reasonable
I5	ELECTROMETALLURGICAL TREATMENT	Reasonable
I6	GLASS MATERIAL OXIDATION/DISSOLUTION SYSTEM	Eliminated (Technical Maturity)

REACTOR AND ACCELERATOR OPTIONS

R1	EURATOM MOX FABRICATION/REACTOR BURNING	Eliminated (Timeliness)
R2	EXISTING LWRs	Reasonable
R2A	PARTIALLY COMPLETED LWRs	Reasonable
R3	EVOLUTIONARY OR ADVANCED LWRs	Reasonable
R4	NAVAL PROPULSION REACTORS	Disqualified (Transparency)
R5	MODULAR HELIUM REACTORS	Eliminated (Technical Maturity)
R6	CANDU HEAVY WATER REACTORS	Reasonable
R7	ADVANCED LIQUID METAL REACTORS WITH PYROPROCESSING	Eliminated (Technical Maturity, ES&H)
R8	ACCELERATOR CONVERSION/MOLTEN SALT	Eliminated (Technical Maturity)
R9	ACCELERATOR CONVERSION/PARTICLE BED	Eliminated (Technical Maturity)
R10	EXISTING LWRs WITH REPROCESSING	Disqualified (Theft/Diversion, Policy)
R11	ADVANCED LWRs WITH REPROCESSING	Disqualified (Theft/Diversion, Policy)
R12	ACCELERATOR-DRIVEN MODULAR HELIUM REACTORS	Eliminated (Technical Maturity)
R13	ADVANCED LIQUID METAL REACTORS WITH RECYCLE	Disqualified (Technical Maturity, Policy)
R14	PARTICLE BED REACTORS	Eliminated (Technical Maturity)
R15	MOLTEN SALT REACTORS	Eliminated (Technical Maturity)

[a] In this option, the present DWPF at SRS would have a new, specially designed melter installed. Much of the supporting equipment would require major retrofitting for this application because DWPF was not designed for criticality control. Retrofitting the DWPF would create additional total personnel radiation exposure and would significantly interfere with its mission to stabilize and treat HLW, resulting in delays and cost escalation. Note that eliminating this "DWPF Upgrade" variant does not preclude other DWPF-related variants of the Vitrification and Ceramic Immobilization Alternatives (such as adding an adjunct melter adjacent to the DWPF or the can-in-canister approach in the DWPF) if these other variants do not introduce increased radiation or Pu criticality concerns into the DWPF. Can-in-canister at a retrofitted DWPF is discussed in Appendix O and would be examined along with other site-specific alternatives in subsequent NEPA review tiered from the PEIS.

Note: ES&H=Environmental Safety and Health.

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Figure S.3–2. Results of the Screening Process—Surplus Plutonium Disposition Options.

No Action Alternative in the Storage and Disposition PEIS. For other long-term storage alternatives, existing Pu stored at RFETS (approximately 12.9 t [14.2 tons], as stated in DOE's Openness Initiative of December 7, 1993) would be moved to one or more other Pu storage sites. Therefore, DOE developed a subalternative under the Upgrade at Multiple Sites Alternative to analyze the storage of all or some Pu from RFETS at each candidate site. The phaseout of Pu storage at RFETS is also analyzed.

Two other locations, LANL and LLNL, also store quantities of Pu material. As of September 1994, LLNL stored 0.3 t (0.3 tons), and LANL stored 2.7 t (3.0 tons) of Pu. Quantities at LLNL are weapons R&D and operational feedstock materials not surplus to government needs; consequently, none of the Pu stored at LLNL falls within the scope of the Storage and Disposition PEIS. Some Pu material at LANL does fall within scope of the Storage and Disposition PEIS. Approximately 1.5 t (1.7 tons) of Pu material at LANL have been declared surplus to national security needs. As a result, storage of the current Pu inventory at LANL is analyzed under the No Action Alternative. Because LANL is not a candidate storage site, environmental impacts associated with a partial phaseout at LANL and relocation of the surplus Pu material to one or more of the candidate storage sites, is analyzed.

DEVELOPMENT OF DISPOSITION ALTERNATIVES

For disposition, DOE began with 37 potential alternatives (see Figure S.3–2), including the No Disposition Action in which the surplus Pu would remain in long-term storage. Using the same general criteria as those for long-term storage, DOE identified 11 alternatives for surplus Pu disposition, including deep borehole (immobilization), deep borehole (direct emplacement), vitrification (borosilicate glass immobilization), ceramic immobilization, electrometallurgical treatment, glass material oxidation/dissolution, Euratom MOX fuel fabrication/reactor burning, existing LWRs, partially completed LWRs, evolutionary or advanced LWRs, and CANDU reactors. Upon further study of supply/demand conditions for Euratom MOX fuel and due to lack of maturity of the technologies for glass material oxidation/dissolution, DOE deleted the glass material oxidation/dissolution and the Euratom MOX fuel fabrication/reactor burning alternatives. However, MOX fuel fabrication (but not reactor burning) at European facilities remains a reasonable short-term option for the Existing LWR Alternative. Therefore, a total of nine reasonable disposition alternatives in addition to the No Disposition Action and the Preferred Alternative, were selected for analysis in the PEIS. These alternatives were grouped into three categories: Deep Borehole, Immobilization, and Reactor.

Facilities under each alternative within the Immobilization and Deep Borehole Categories could be designed such that they could disposition all the surplus Pu over their operating lives. Each disposition alternative under the Reactor Category would consist of reactors that could use all the MOX fuel produced from surplus Pu. However, existing surplus Pu comes in various forms, and some of these forms may not be suitable for conversion to MOX fuel without specialized chemical processing. The Preferred Alternative for disposition of surplus weapons-usable Pu, discussed previously, involves a combination of disposition alternatives.The Storage and Disposition PEIS identifies the reasonable long-term storage and disposition alternatives as follows:

Deep Borehole

A borehole extended several kilometers below the water table into ancient, geologically stable rock formations.

Storage:

- Storage Alternatives
  - Preferred Alternative (Combination)
  - Upgrade at Multiple Sites Alternative
  - Consolidation of Pu Alternative
  - Collocation of Pu and HEU Alternative
  - No Action Alternative

- Candidate Storage Sites
  - Hanford
  - NTS
  - INEL
  - Pantex
  - ORR
  - SRS

Environmental impacts of each storage alternative and the No Action Alternative are analyzed for each of the six candidate storage sites, to allow (1) the comparison of impacts by site for each alternative and (2) the comparison of impacts by alternative for each site. As a result, decisions can be made to select a single storage alternative for all sites or a combination of different alternatives for different sites.

Disposition:

- Preferred Alternative (Combination)

- Deep Borehole Category
  - Direct Disposition Alternative
  - Immobilized Disposition Alternative

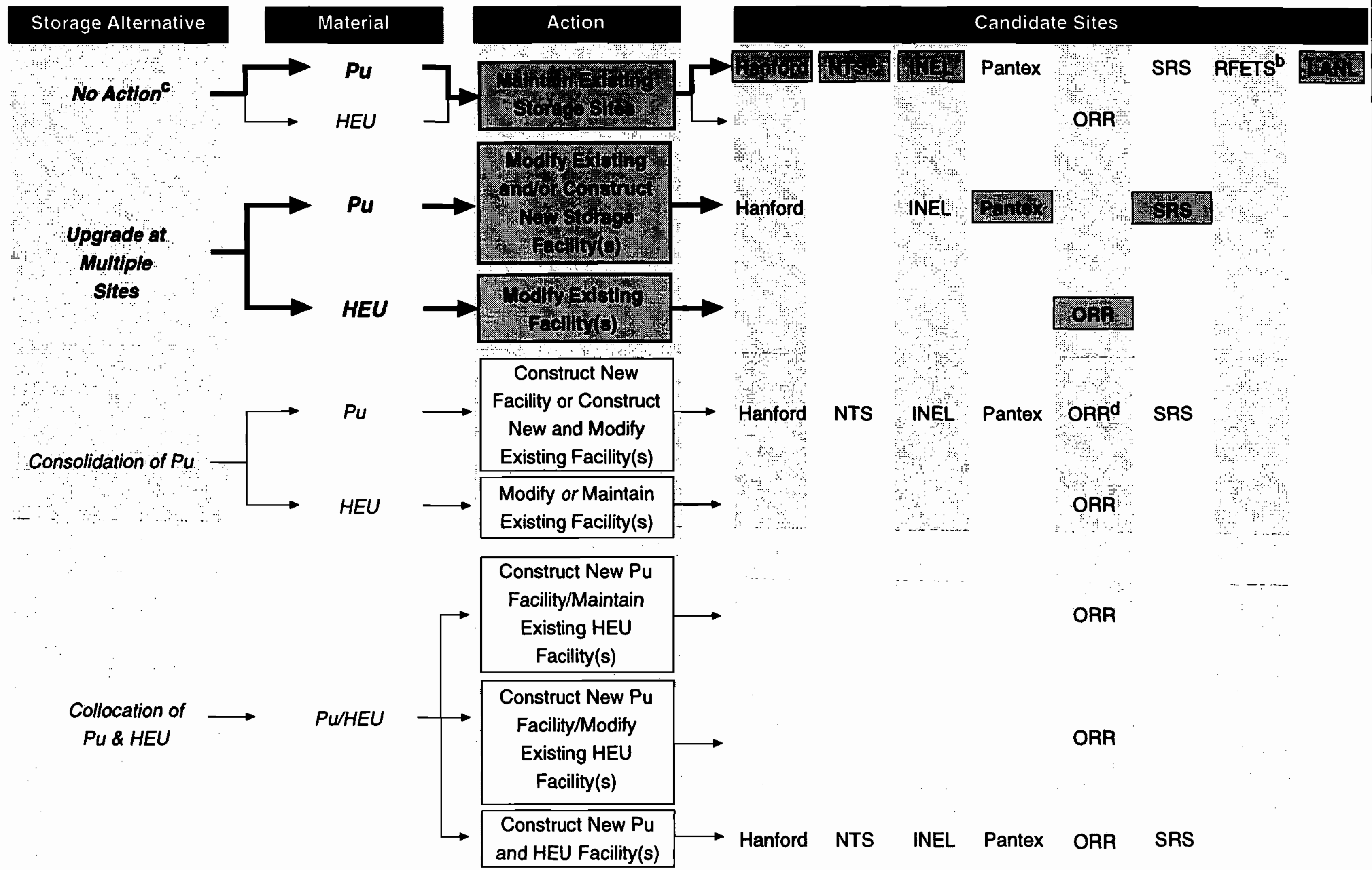
- Immobilization Category
  - Vitrification Alternative
  - Ceramic Immobilization Alternative
  - Electrometallurgical Treatment Alternative

- Reactor Category
  - Existing LWR Alternative
  - Partially Completed LWR Alternative
  - Evolutionary LWR Alternative
  - CANDU Reactor Alternative

- No Disposition Action

The Storage and Disposition PEIS analyzes the reasonable alternatives in addition to the No Action Alternative. For the No Action Alternative, all weapons-usable fissile materials would remain in storage at existing sites using proven nuclear material safeguards and security procedures. For the No Disposition Action Alternative, all weapons-usable fissile materials would remain in storage. The conceptual structures for the long-term storage and disposition alternatives, including the Preferred Alternative (in boldface text and shaded boxes), are presented in Figures S.3–3 and S.3–4, respectively. A more detailed description of these alternatives follows.

[Text deleted.]



[a] Although NTS does not currently store either Pu or HEU, the No Action Alternative is included here as a basis against which other storage and disposition alternatives are analyzed.
[b] As part of the Preferred Alternative, Pu storage at RFETS would be phased out with pits sent to Pantex and non-pit materials sent to SRS.
[c] Under the No Action Alternative, DOE would not undertake any new construction projects except those that are considered part of ongoing site operations to ensure continued safe, secure storage. However, any new facility construction deemed necessary to maintain safe, secure storage would be addressed in appropriate, individual site-specific EISs and site development plans.
[d] If Pu is consolidated at ORR, the presence of the HEU material already residing at the Y-12 Plant would create a HEU collocation condition and is therefore portrayed as the Collocation Alternative.
Note: Bold text and shaded boxes indicate Preferred Alternative.

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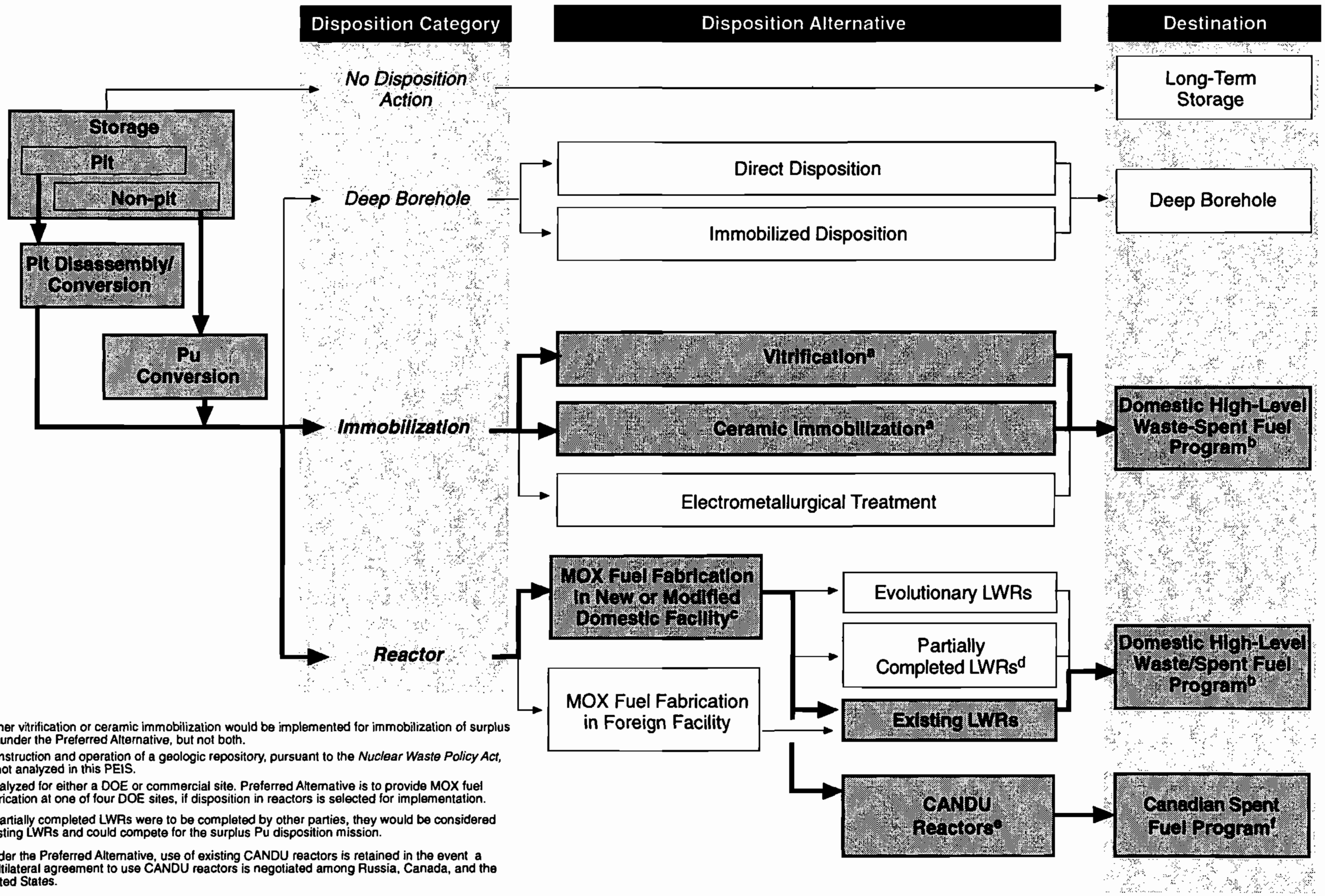
Figure S.3–3. Long-Term Storage Alternatives, Including the Preferred Alternative for Storage.



[a] Either vitrification or ceramic immobilization would be implemented for immobilization of surplus Pu under the Preferred Alternative, but not both.

[b] Construction and operation of a geologic repository, pursuant to the *Nuclear Waste Policy Act*, is not analyzed in this PEIS.

[c] Analyzed for either a DOE or commercial site. Preferred Alternative is to provide MOX fuel fabrication at one of four DOE sites, if disposition in reactors is selected for implementation.

[d] If partially completed LWRs were to be completed by other parties, they would be considered existing LWRs and could compete for the surplus Pu disposition mission.

[e] Under the Preferred Alternative, use of existing CANDU reactors is retained in the event a multilateral agreement to use CANDU reactors is negotiated among Russia, Canada, and the United States.

[f] The Canadian Spent Fuel Program is not part of this evaluation.

Note: Bold text and shaded boxes indicate Preferred Alternative.

Figure S.3–4. Surplus Plutonium Disposition Alternatives, Including the Preferred Alternative for Disposition.

S.4 DESCRIPTION OF ALTERNATIVES

S.4.1 LONG-TERM STORAGE ALTERNATIVES AND RELATED ACTIVITIES

No Action

[Text deleted.]

Under the No Action Alternative, all weapons-usable fissile materials would remain at existing storage sites. Maintenance at existing storage facilities would be done as required to ensure safe operation for the balance of the facility's useful life. Sites covered under the No Action Alternative include Hanford, INEL, Pantex, ORR, SRS, RFETS, and LANL. Although there are no weapons-usable fissile materials within the scope of the PEIS stored currently at NTS, it is also analyzed under No Action to provide an environmental basis against which impacts of the storage and disposition alternatives are analyzed. The Preferred Alternative for storage calls for No Action at Hanford, INEL, and LANL pending disposition.

Preferred Alternative

The Preferred Alternative for storage is described in Section S.2.

Upgrade at Multiple Sites

Under this alternative for storage, DOE would either modify certain existing facilities or build new facilities, depending on the site's requirements to meet standards for nuclear material storage facilities, and would utilize existing site infrastructure to the extent possible. These modified or new facilities would be designed to operate for up to 50 years. Pu materials currently stored at Hanford, INEL, Pantex, and SRS would remain at those four sites, and HEU would remain at ORR. This alternative does not apply to NTS because NTS does not currently store weapons-usable fissile materials that are within the scope of the PEIS.

A subalternative of relocating portions of the Pu inventory from RFETS and LANL (for a total of 14.4 t [15.9 tons] according to DOE's Openness Initiatives of December 7, 1993, and February 6, 1996, respectively) to one or more of the four existing Pu storage sites is analyzed. Storage without strategic reserve and weapons R&D materials is also included as a subalternative.

Within some of the five candidate storage sites under this alternative, there are one or more storage options. A summary of these options is presented in Table S.4.1–1.

Table S.4.1–1. Long-Term Storage Options for the Upgrade at Multiple Sites Alternative[a]

Candidate Site	Storage Option
Hanford	Modify Existing Fuels and Materials Examination Facility for Pu Storage, or Construct New 200 West Area Facility for Pu Storage
INEL	Modify Existing and Construct New Argonne National Laboratory-West Facilities for Continued Pu Storage
Pantex (Preferred Alternative)	Modify Existing Zone 12 South Facilities for Continued Pu Storage
ORR (Preferred Alternative)	Modify Existing Y–12 Plant Facilities for Continued HEU Storage
SRS (Preferred Alternative)	Modify New Actinide Packaging and Storage Facility for Continued Pu Storage

[a] Proposed storage facility locations were primarily based on optimal use of existing facilities, and are in accordance with current site development and utilization plans and proposals.

Consolidation of Plutonium

Under this alternative, Pu materials at existing sites would be removed, and the entire DOE inventory of Pu would be consolidated at one site, while the HEU inventory would remain at ORR. Again, the four sites with existing Pu storage are candidate sites for Pu consolidation. In addition, NTS and ORR are candidate sites for this alternative. Consolidation of Pu at ORR would result in a situation in which inventories of Pu and HEU are collocated at one site; this alternative is therefore analyzed as the Collocation Alternative at ORR.

A subalternative to account for the separate storage without strategic reserve and weapons R&D materials is also included. Storage options for the six candidate sites under this alternative are presented in Table S.4.1–2.

Table S.4.1–2. Long-Term Storage Options for the Consolidation of Plutonium Alternative

Candidate Site[a]	Storage Option
Hanford	Construct New Pu Storage Facility Adjacent to 200 East Area
NTS	Modify Existing Tunnel Drifts and Construct New Material Handling Building at the P-Tunnel, or Construct New Pu Storage Facility in Area 6
INEL	Construct New Pu Storage Facility Adjacent to the Idaho Chemical Processing Plant
Pantex	Construct New and Modify Existing Zone 12 South Facilities, or Construct New Pu Storage Facility in Zone 12 South
SRS	Construct New Pu Storage Facility Adjacent to Z Area

[a] Consolidation of Pu at ORR results in a collocation condition with HEU. See ORR Collocation Alternative in Table S.4.1–3.

Collocation of Plutonium and Highly Enriched Uranium

Under the Collocation Alternative, the entire DOE inventory of Pu would be consolidated and collocated at the same site as the HEU inventory. The six candidate sites are Hanford, NTS, INEL, Pantex, ORR, and SRS.

A subalternative for the separate storage without strategic reserve and weapons R&D materials is also included. Storage options for the six candidate sites under this alternative are presented in Table S.4.1–3.

Table S.4.1–3. Long-Term Storage Options for the Collocation of Plutonium and Highly Enriched Uranium Alternative

Candidate Site	Storage Option
Hanford	Construct New Pu and HEU Storage Facilities Adjacent to 200 East Area
NTS	Modify Existing Tunnel Drifts and Construct New Material Handling Building at the P-Tunnel, or Construct New Pu and HEU Storage Facilities in Area 6
INEL	Construct New Pu and HEU Storage Facilities Adjacent to the Idaho Chemical Processing Plant
Pantex	Construct New Pu and HEU Storage Facilities in Zone 12 South
ORR	Construct New Pu Storage Facility Northwest of Oak Ridge National Laboratory and Maintain Existing (No Action) HEU Storage Facilities at Y–12 Plant, or Construct New Pu Storage Facility Northwest of Oak Ridge National Laboratory and Modify Existing HEU Storage Facilities at Y–12 Plant, or Construct New Pu and HEU Storage Facilities Northwest of Oak Ridge National Laboratory
SRS	Construct New Pu and HEU Storage Facilities Adjacent to Z Area

S.4.2 PLUTONIUM DISPOSITION ALTERNATIVES AND RELATED ACTIVITIES

[Text deleted.] The disposition technologies analyzed in the PEIS are those that would convert surplus Pu into a form that meets the Spent Fuel Standard. For the purpose of environmental impact analyses for the various disposition alternatives, both generic and specific sites are used to provide perspective on these alternatives. Under each alternative, there are various ways to implement the alternative. These "variants" (such as the can-in-canister[13]) are shown in Table S.4.2–1 to provide a range of available options for consideration.

The first step in Pu disposition is to remove the surplus Pu from storage, then process this material in a pit disassembly/conversion facility (for pits, a component of nuclear weapons) or in a Pu conversion facility (for non-pit materials). The processing would convert the Pu material into a form suitable for each of the disposition alternatives described in the following sections. The pit disassembly/conversion facility and the Pu conversion facility are assumed to be built at a DOE site. Therefore, the six candidate sites for long-term storage were used to evaluate the potential environmental impacts of constructing and operating these facilities.

No Disposition Action

A "No Pu Disposition" action means disposition would not occur, and surplus Pu-bearing weapon components (pits) and other forms, such as metal and oxide, would remain in storage in accordance with decisions on the long-term storage of weapons-usable fissile materials.

Preferred Alternative

The Preferred Alternative for disposition is described in Section S.2.

Deep Borehole Category

Under this category, surplus weapons-usable Pu would be disposed of in deep boreholes that are drilled at least 4 kilometers (km) (2.5 miles [mi]) into ancient, geologically stable rock formations beneath the water table. The deep borehole provides a geologic barrier against potential proliferation. A generic site is used for the construction and operation of a borehole complex where the surplus Pu would be prepared for emplacement in the borehole. This complex would consist of five major facilities: processing; drilling; emplacing/sealing; waste management; and support (security, maintenance, and utilities).

Direct Disposition

Under the Direct Disposition Alternative, surplus Pu would be removed from storage, processed as necessary, converted to a form suitable for emplacement, packaged, and placed in a deep borehole. The deep borehole would be sealed to isolate the Pu from the accessible environment. Long-term performance of the deep borehole would depend on the stability of the geologic system. A generic site is used for the borehole complex to analyze the environmental impact of this alternative.

Immobilized Disposition

Under the Immobilized Disposition Alternative, the surplus Pu would be removed from storage, processed, and converted to a suitable form for shipment to a ceramic immobilization facility. The output of this facility would be spherical ceramic pellets containing Pu, facilitating handling during transportation and emplacement. The ceramic pellets (about 2.54 centimeters [cm] [1 inch {in}] in diameter and containing 1 percent Pu by weight) would then be placed in drums and shipped to the borehole complex. At the deep borehole site, the ceramic

[13] In the can-in-canister variant, cans of Pu glass or Pu ceramic would be placed in a DWPF canister or a DWPF type canister. This canister would then be filled with borosilicate glass containing HLW. This variant is described in Appendix O of the Final PEIS.

Table S.4.2–1. Description of Variants Under Plutonium Disposition Alternatives

Alternatives Analyzed	Possible Variants
• Deep Borehole Direct Disposition	• Arrangement of Pu in different types of emplacement canisters.
• Deep Borehole Immobilized Disposition	• Emplacement of pellet-grout mix. • Pumped emplacement of pellet-grout mix. • Pu concentration loading, size and shape of ceramic pellets.
• New Vitrification Facilities	• Collocated pit disassembly/conversion, Pu conversion, and immobilization facilities. • Use of either Cs-137 from capsules or HLW as a radiation barrier. • Wet or dry feed preparation technologies. • An adjunct melter adjacent to the DWPF at SRS, in which borosilicate glass frit with Pu (without highly radioactive radionuclides) is added to borosilicate glass containing HLW from the DWPF. • A can-in-canister approach at SRS in which cans of Pu glass (without highly radioactive radionuclides) are placed in DWPF canisters which are then filled with borosilicate glass containing HLW in the DWPF (See Appendix O of the Final PEIS). • A can-in-canister approach similar to above but using new facilities at sites other than SRS.
• New Ceramic Immobilization Facilities	• Collocated pit disassembly/Pu conversion, and immobilization facilities. • Use of either Cs-137 from capsules or HLW as a radiation barrier. • Wet or dry feed preparation technologies. • A can-in-canister approach at SRS in which the Pu is immobilized without highly radioactive radionuclides in a ceramic matrix and then placed in the DWPF canisters that are then filled with borosilicate glass containing HLW (See Appendix O of the Final PEIS). • A can-in-canister approach similar to above but using new facilities at sites other than SRS.
• Electrometallurgical Treatment (glass-bonded zeolite form)	• Immobilize Pu into metal ingot form. • Locate at DOE sites other than ANL-W at INEL.
• Existing LWR With New MOX Facilities	• Pressurized or Boiling Water Reactors. • Different numbers of reactors. • European MOX fuel fabrication. • Modification/completion of existing facilities for MOX fabrication. • Collocated pit disassembly/conversion, Pu conversion, and MOX facilities. • Reactors with different core management schemes (Pu loadings, refueling intervals).
• Partially Completed LWR With New MOX Facilities	• Same as for existing LWR (except that MOX fuel would not be fabricated in Europe).
• New Evolutionary LWR With New MOX Facilities	• Same as for partially completed LWR.
• Existing CANDU Reactor With New MOX Facilities	• Different numbers of reactors. • Modification/completion of existing facilities for MOX fabrication. • Collocated pit disassembly/conversion, Pu conversion, and MOX facilities. • Reactors with different core management schemes (Pu loadings, refueling intervals).

pellets would be mixed with ceramic pellets containing no Pu and fixed with grout during emplacement. The deep borehole would be sealed to isolate the Pu from the accessible environment. Long-term performance of the deep borehole would depend on the stability of the geologic system.

Although a generic site is used for the borehole complex in this alternative, the ceramic immobilization facility is assumed to be built at a DOE site. Therefore, the six candidate sites for long-term storage were used to evaluate the environmental impact of the facility.

Immobilization Category

Under this category of alternatives, surplus Pu would be immobilized to create a chemically stable form for disposal in a geologic repository pursuant to the *Nuclear Waste Policy Act* (NWPA).[14] The Pu material may be mixed with HLW or other radioactive isotopes and immobilized to create a radiation field that could serve as a proliferation deterrent, along with safeguards and security comparable to those of commercial spent nuclear fuel, thereby achieving the Spent Fuel Standard. All immobilized Pu would be encased in stainless steel canisters and would remain in onsite vault-type storage until a separate geologic repository pursuant to the NWPA is operational.

Vitrification

Under the Vitrification Alternative, surplus Pu would be removed from storage, processed, packaged, and transported to the vitrification facility. In this facility, the Pu would be mixed with glass frit and the highly radioactive isotope cesium-137 (Cs-137) or HLW to produce borosilicate glass logs (a slightly different process, using HLW, would be used for the can-in-canister variant discussed in Appendix O of the Final PEIS). The Cs-137 isotope could come from the cesium chloride (CsCl) capsules currently stored at Hanford or from existing HLW if the site selected for vitrification already manages HLW. Each glass log produced from the vitrification facility would contain about 84 kilograms (kg) (185 pounds [lb]) of Pu.

The vitrification facility is assumed to be built at a DOE site. Therefore, the six candidate sites for long-term storage were used to evaluate the environmental impact of this alternative.

Ceramic Immobilization

Under the Ceramic Immobilization Alternative, surplus Pu would be removed from storage, processed, packaged, and transported to a ceramic immobilization facility. In this facility, the Pu would be mixed with nonradioactive ceramic materials and Cs-137 or HLW to produce ceramic disks (a slightly different process, using HLW, would be used for the can-in-canister variant). Each disk would be approximately 30 cm (12 in) in diameter and 10 cm (4 in) thick, and would contain approximately 4 kg (9 lb) of Pu. The Cs-137 or HLW would be provided as previously described.

The ceramic immobilization facility is assumed to be built at a DOE site. Therefore, the six candidate sites for long-term storage were used to evaluate the environmental impact of this alternative.

Electrometallurgical Treatment

Under the Electrometallurgical Treatment Alternative, surplus Pu would be removed from storage, processed, packaged, and transported to new or modified facilities for electrometallurgical treatment. This process could immobilize surplus fissile materials into a glass-bonded zeolite (GBZ) form. With the GBZ material, the Pu is in the form of a stable, leach-resistant mineral that is incorporated in durable glass materials.[15]

[14] Also referred in the PEIS as a geologic, permanent, or HLW repository.

[Text deleted.]

Reactor Category

The reactor alternatives considered in the Storage and Disposition PEIS would utilize surplus Pu in MOX fuel for use in non-defense reactors. The irradiated MOX fuel would meet the Spent Fuel Standard to reduce the proliferation risks of the Pu material, and the reactors would also generate revenues through the sale of electricity. MOX fuel would be used in a once-through fuel cycle, with no reprocessing or subsequent reuse of spent fuel. The spent nuclear fuel generated by the reactors would then be sent to a geologic repository pursuant to the NWPA.

Because the United States does not have a MOX fuel fabrication facility or capability, a dedicated facility would likely have to be constructed or modified at a U.S. Government or existing commercial fuel fabricator's site. The surplus Pu from storage would be processed, converted to PuO_2, and transferred to the MOX fuel fabrication facility. In this facility, PuO_2 and UO_2 (from existing domestic sources) would be blended and fabricated into MOX pellets, loaded into fuel rods, and assembled into fuel bundles suitable for use in the reactor alternatives under consideration. The PEIS evaluates the potential environmental impacts of the MOX fuel fabrication facility at the six DOE sites and at a generic commercial site. MOX fuel fabrication at existing European facilities would be a viable option in the near-term to meet the initial fuel needs of the Existing LWR Alternative, pending availability of a domestic MOX fuel fabrication facility.[16]

Existing Light Water Reactor

Under the Existing LWR Alternative, the MOX fuel containing surplus Pu would be fabricated and transported to existing commercial LWRs in the United States, where the MOX fuel would be used instead of conventional UO_2 fuel. The LWRs employed for domestic electric power generation are pressurized water reactors (PWRs) and boiling water reactors (BWRs). Both types of reactors use the heat produced from nuclear fission reactions to generate steam that drives the turbines and generates electricity. The Storage and Disposition PEIS assumes a throughput of 3 to 5 t/year (yr) (3.3 to 5.5 tons/yr) for disposition of surplus Pu; three to five LWRs would be used. A sample of operating reactors (eight PWRs and four BWRs built after 1975) was compiled to obtain generic operating characteristics for environmental analysis of this alternative.

It is possible that an existing LWR can be configured to produce tritium, consume Pu as fuel, and generate revenue through the production of electricity. This configuration is called a multipurpose reactor. Environmental analysis of the multipurpose reactor is included in Chapter 4 of the *Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling* (TSR PEIS) (DOE/EIS-0161, October 1995). In the TSR PEIS ROD (December 1995), the multipurpose reactor was preserved as an option for future consideration. Information on the Fast Flux Test Facility (FFTF) at Hanford and the costs and benefits of the multipurpose reactor is presented in Appendix N of the Final PEIS.

Partially Completed Light Water Reactor

Under the Partially Completed LWR Alternative, commercial LWRs on which construction has been halted would be completed. The completed reactors would use MOX fuel containing surplus Pu. The characteristics of

[15] The Department has recently issued a FONSI (61 FR 25647) and decision to proceed with the limited demonstration of the electrometallurgical treatment process at Argonne National Laboratory-West (ANL-W) at INEL for processing up to 125 spent fuel assemblies from the Experimental Breeder Reactor II (100 driver and 25 blanket assemblies). Although this alternative could be conducted at other DOE sites, ANL-W is described in the PEIS as the representative site for analysis. The National Research Council prepared a report called *An Evaluation of the Electrometallurgical Approach for Treatment of Excess Weapons Plutonium* (National Academy Press, Washington, DC, 1996). The results of this evaluation will be considered in DOE's decision-making process for Pu disposition.

[16] European MOX fuel fabrication would only be available in the near-term, and is not a part of the Preferred Alternative.

these LWRs would be essentially the same as those of the existing LWRs discussed in the Existing LWR Alternative. The Bellefonte Nuclear Plant located along the west bank of the Tennessee River in Alabama is used as a representative site for the environmental analysis of this alternative. Two reactor units (such as those at the Bellefonte Nuclear Plant) would be needed to implement this alternative.

Evolutionary Light Water Reactor

The evolutionary LWRs are improved versions of existing commercial LWRs. Two design approaches are considered in the Storage and Disposition PEIS. The first is a large PWR or BWR similar to the size of the existing PWR and BWR. The second is a small PWR approximately one-half the size of the large PWR. Two large or four small evolutionary LWRs would be needed to implement this alternative.

Under each design approach for this alternative, evolutionary LWRs would be built at a DOE site. Therefore, the six candidate sites for long-term storage were used to evaluate the environmental impact of this alternative.

Canadian Deuterium Uranium Reactor

Under the CANDU Reactor Alternative, the MOX fuel containing surplus Pu would be fabricated in a U.S. facility, then transported for use in a commercial heavy water reactor in Canada. The Ontario Hydro Nuclear Bruce-A Generating Station identified by the Canadians is used as a representative site for evaluation of this alternative. This station is located on Lake Huron about 300 km (186 mi) northeast of Detroit, Michigan. Environmental analysis of domestic activities up to the U.S./Canadian border is presented in the PEIS. The use of CANDU reactors would be subject to the policies, regulations, and approval of the Federal and Provincial Canadian Governments. Pursuant to Section 123 of the *Atomic Energy Act*, any export of MOX fuel from the United States to Canada must be made under an agreement for cooperation between the two countries. Spent fuel generated by a CANDU reactor would be accommodated within the Canadian spent fuel program.

S.5 APPROACH TO ENVIRONMENTAL IMPACT ANALYSIS

The environmental impact assessment addresses the full range of natural and human resource, and issue areas pertinent to the sites considered for the long-term storage and disposition alternatives. The resource/issue areas are land resources, site infrastructure, air quality and noise, water resources, geology and soils, biological resources, cultural and paleontological resources, socioeconomics, public and occupational health and safety, waste management, intersite transportation, and environmental justice.

A region of influence (ROI) for each resource/issue area is identified and analyzed for each candidate site for long-term storage and each analysis site for disposition. Land resources address land use; land-use compatibility with existing land-use plans, controls, and policies; and the potential for visual resource impacts. Site infrastructure impacts are assessed by comparing the electrical power, fuel, and transportation network requirements against the existing capacities at each candidate site. Air quality and noise impacts focus on air pollutants and noise emissions and their compliance with the National Ambient Air Quality Standards, State air quality standards, and local government standards for noise.

For water resources, the water consumption requirements of each alternative were compared to the availability of surface and groundwater sources at each site, the potential effects of wastewater discharges on surface and groundwater quality are evaluated, and the site's location relative to floodplains assessed. Similarly, geology and soils are evaluated in terms of site suitability and soil erosion potential. Biological resources are evaluated in terms of the potential for impacts to terrestrial and aquatic resources, wetlands, and threatened and endangered species. Cultural and paleontological resources addresses the potential for disturbance to prehistoric, historic, Native American, and paleontological resources. The employment and income effects of new job creation and the attendant demands on community services and local transportation are analyzed for socioeconomics.

Both the public and onsite worker exposure to ionizing radiation and hazardous chemicals and the resultant increase in cancer fatality risk to public and occupational health and safety are assessed for normal operations and accident conditions. The analysis of radiation impacts includes consideration of National Emission Standards for Hazardous Air Pollutants (NESHAPs). The widely used algorithms for estimating the risk of latent cancers from radiation are based on high dose rates, and impacts are then extrapolated to low rates by presumed linear response models. These models are known to overestimate the risk for low dose rates. For the purposes of presentation in the PEIS, the impacts calculated from the linear model are treated as an upper bound case, consistent with the widely used methodologies for quantifying radiogenic health impacts. This does not imply that health effects are expected. Moreover, in cases where the upper bound estimates predict a number of latent cancer deaths that is greater that 1, this does not imply that the latent cancer death(s) are identifiable to any individual.

The additional wastes generated by each alternative are compared to existing and planned treatment, storage, and disposal capacities for potential impacts to waste management. Waste management assumptions are based on current site practices and are contingent upon decisions to be made following completion of the *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (DOE/EIS-0200).

The increased number of potential fatalities from truck accidents during the transportation of weapons-usable fissile materials among the various DOE sites and proposed facilities is evaluated for intersite transportation. Environmental justice addresses the potential for disproportionately high and adverse impacts to minority and low-income populations within 80 km (50 mi) of the sites.

The Storage and Disposition PEIS analyzes six candidate sites for the long-term storage of weapons-usable fissile materials. These sites are Hanford, NTS, INEL, Pantex, ORR, and SRS. These same sites were also used to evaluate the construction and operation of various facilities required for the disposition alternatives. These facilities include the pit disassembly/conversion and the Pu conversion facilities common to all disposition alternatives, the MOX fuel fabrication facility common to all reactor alternatives, the ceramic immobilization facility for the deep borehole alternative, the glass vitrification and ceramic immobilization facilities, and the Evolutionary LWR Alternative.

Other sites analyzed for Pu disposition are the ANL-W site at INEL for the Electrometallurgical Treatment Alternative and the Bellefonte Nuclear Plant for the Partially Completed LWR Alternative. These sites are used for analysis only and do not represent a DOE proposal or preference. Alternative sites may be analyzed in subsequent NEPA documents. A generic borehole site is evaluated for the alternatives in the Deep Borehole Category.[17] The Existing LWR Alternative analysis uses generic operating characteristics developed from 12 operating LWRs within the United States, and impacts are assessed using a generic site that was developed based on a composite of existing sites.

S.6 PREFERRED ALTERNATIVE SUMMARY OF IMPACTS

This section summarizes the maximum site impacts that would result at Hanford, INEL, Pantex, and SRS from combining the Preferred Alternative for storage with the Preferred Alternative for disposition at each of these sites. The Preferred Alternative identifies these sites as possible locations for all or some Pu disposition activities. The siting, construction, and operation of disposition facilities and variants would be covered in future tiered NEPA analyses. To the extent practical, DOE would use modified existing buildings and facilities for portions of the disposition activities. The use of existing buildings would reduce the environmental impacts and resource usages identified in this section.

[17] If either Borehole Alternative were selected, DOE would prepare a siting study and tiered NEPA documentation to identify and assess impacts of potential alternative borehole sites. DOE would analyze and compare existing and new buildings and facilities for the technologies chosen as part of the Preferred Alternative in subsequent, tiered NEPA review.

The preferred strategy for disposition is a combination of alternatives which includes operating existing reactors with MOX fuel and immobilization of some of the surplus Pu. The impacts from the operation of most of the existing domestic LWRs would not affect DOE sites. For purposes of analysis, approximately 70 percent of the surplus Pu, which is high purity material, could be readily converted into MOX fuel for use in nuclear reactors. The Preferred Alternative is to use existing reactors. DOE would retain using CANDU reactors in the event of a multilateral agreement among Russia, Canada, and the United States. For purposes of analysis, approximately 30 percent (low purity Pu) would be immobilized in glass or ceramic forms although much of it could be purified with chemical processing and used as MOX fuel in reactors. Disposition by use in reactors would require the construction of a MOX fuel fabrication facility and a pit disassembly/conversion facility at DOE sites. Disposition by immobilization would require the construction of a Pu conversion facility and an immobilization facility (either ceramic immobilization or vitrification) at a DOE site. Four DOE sites (Hanford, INEL, Pantex, and SRS) would be potential locations for MOX fuel fabrication and pit disassembly/conversion facilities, and two sites (Hanford and SRS) for the Pu conversion and immobilization facilities.

The following sections describe the total life cycle impacts that would result from the implementation of the Preferred Alternative at the DOE sites identified for potential placement of the disposition facilities. The analysis conservatively assumed a maximum impact scenario where two or four new disposition facilities could be built at the same DOE site. For immobilization, the analysis conservatively uses impacts from the ceramic immobilization facility since they are generally larger than the impacts from the vitrification facility. If existing facilities (such as the DWPF at SRS and the FMEF at Hanford) were used for some of the disposition activities, the impacts would be reduced.

Land Resources

Collocating disposition facilities at Hanford, INEL, Pantex, or SRS would likely minimize land-use impacts due to the sharing of land resources. In addition, optimal use of existing buildings and facilities would occur where possible. All four sites would have adequate land area to accommodate the facilities. Most disposition facilities would be separated from the site boundary by a 1.6-km (1-mi) buffer zone. For all four DOE sites, construction and operation would not affect other onsite or offsite land uses. No prime farmlands exist onsite. Construction and operation would be compatible with site, State, and local land-use plans, policies, and controls. This section describes the impacts to land resources from constructing and operating the Preferred Alternative storage and disposition facilities for each site.

Hanford Site. Plutonium materials would continue to be stored at the Plutonium Finishing Plant (PFP) in the 200 West Area, pending decisions on their disposition. The potential pit disassembly/conversion, Pu conversion, ceramic immobilization, and MOX facilities would be located on vacant land in the 200 Area adjacent to 200 East. The total area disturbed during construction would be approximately 191 hectares (ha) (472 acres); operation would require approximately 133 ha (329 acres). Construction and operation of the facilities would conform to existing and future land use plans as described in the current *Hanford Site Development Plan* and ongoing discussions in the comprehensive land-use planning process.

Construction and operation of these facilities would also be consistent with the industrialized landscape character of the 200 Area and with the current Visual Resource Management (VRM) Class 5 designation. The ceramic immobilization facility or MOX facility could have stack plumes that could be visible from public viewpoints with high sensitivity levels, including State Highways 24 and 240 and the city of Richland; however, the proposal would be compatible with the existing industrial character of the Hanford area.

Idaho National Engineering Laboratory. Plutonium materials would continue to be stored at the Idaho Chemical Processing Plant (ICPP) and at ANL-W in the Zero Power Physics Reactor (ZPPR) and Fuel Manufacturing Facility (FMF) vaults, pending decisions on their disposition. The potential pit disassembly/conversion and MOX facilities would be located on undeveloped land within or near the ICPP security area. The total area disturbed during construction would be approximately 135 ha (334 acres);

operation would require approximately 93 ha (230 acres). Construction and operation would be consistent with the *Idaho National Engineering Laboratory Site Development Plan*, which designates the ICPP as situated within the Central Core Area/Prime Development Zone at INEL.

Construction and operation of these facilities would also be consistent with the industrialized landscape character of the ICPP and with the current VRM Class 5 designation. The MOX facility may have stack plumes that could be visible from off-site public viewpoints; however, the proposal would be compatible with the existing industrial character of the area.

Pantex Plant. Buildings 12-66 and 12-82 in Zone 12 South would be modified to accommodate the long-term storage of Pantex pits and RFETS pits under the Preferred Alternative. Construction and operation would require less than 1 ha (2.5 acres) and conform with the current *Pantex Site Development Plan*, which includes as part of its master plan the Fissile Material Storage Facility in Zone 12. Zone 12 is also the potential location for the pit disassembly/conversion facility. Construction and operation would require less than 14 ha (35 acres) and conform with the Pantex Site Development Plan, which designates Zone 12 for weapon assembly/disassembly. The total area disturbed during construction would be approximately 135 ha (334 acres); operation would require approximately 93 ha (230 acres). When completed, the potential MOX fuel fabrication facility would be located on previously undeveloped land in Zone 11, which is currently designated for applied technology. However, Pantex could revise the site development plan to accommodate the potential MOX facility.

The existing Zone 12 VRM Class 5 designation would not change due to the Preferred Alternative. The MOX facility in Zone 11 may have stack plumes that could be visible from off-site viewpoints; however, the proposal would be compatible with the existing site industrial character of the area.

Savannah River Site. The APSF in F-Area would be modified to accommodate the long-term storage of SRS non-pit Pu material and RFETS non-pit Pu material for the Preferred Alternative. Approximately 191 ha (472 acres) of vacant land in the F-Area would be disturbed during construction of the pit disassembly/conversion, Pu conversion, MOX fuel fabrication, and ceramic immobilization facilities. The completed facilities would occupy approximately 133 ha (329 acres). Construction and operation would conform with existing and future land use as designated by the current *Savannah River Site Development Plan*. According to the Plan, current F-Area land use is designated industrial operations, while the future land-use category is primary industrial mission. Although the proposal would convert undeveloped land, forested land, and a very small portion of National Environmental Research Park lands, the action would conform with site land-use plans.

Construction and operation of the upgrade storage, pit disassembly/conversion, Pu conversion, and ceramic immobilization facilities would be consistent with the industrial landscape character and current VRM Class 5 designation of the F-Area. Construction and operation of the MOX facility would change the current VRM Class 4 designation of the proposed site north of the P-Reactor Area to Class 5. The ceramic immobilization and MOX facilities may have stack plumes; however, because of hilly terrain, visual effects to public access roads with high sensitivity levels would not be apparent.

Site Infrastructure

The resource requirements for the construction of the proposed facilities are not expected to exceed site capabilities for any of the sites evaluated. At Hanford, the planned facilities use natural gas as the primary utility fuel, and the total requirement for natural gas (13,609,000 cubic meters [m^3]/yr [17,800,000 cubic yds {yd^3}/yr]) would be larger than currently available. Since INEL and SRS use fuel oil as the primary utility fuel, use of natural gas in lieu of fuel oil would require additional infrastructure. Final designs for facilities under the Preferred Alternative at INEL and SRS would be adapted to use fuel oil. At SRS the oil requirement would exceed the site availability by 277,750 liters (l)/yr (73,370 gallons [gal]/yr). Additional oil and natural gas requirements could be met by increasing procurement at all sites. Locating the Preferred Alternative disposition actions at any of the analyzed sites would require the construction of additional onsite roads and rail spurs.

Air Quality and Noise

Construction and operation of the proposed facilities under the Preferred Alternative would generate criteria and toxic/hazardous air pollutants. To evaluate air quality impacts at Hanford, INEL, Pantex, and SRS, potential concentrations from the facilities have been compared to Federal and State guidelines.

Concentrations of particulate matter less than or equal to 10 microns in diameter (PM_{10}) and total suspended particulates (TSP) are expected to increase during construction of the facilities. Simultaneous construction of the facilities could result in elevated levels of these pollutants. However, appropriate control measures would be implemented to maintain fugitive emissions within applicable Federal and State ambient air quality standards during construction.

The Prevention of Significant Deterioration (PSD) regulations, which are designed to protect ambient air quality in attainment areas, apply to new sources and major modifications to existing sources. Based on estimated emission rates, PSD permits may be required at all of the sites under consideration for the Preferred Alternative facilities. PSD permits may require inclusion of "offsets" (reductions of existing emissions) for any additional or new emission source.

Noise sources associated with the Preferred Alternative facilities may include construction equipment, increased traffic, ventilation equipment, cooling systems, and emergency diesel generators. The contribution to offsite noise levels would continue to be small at all of the sites because the facilities associated with the Preferred Alternative would be a sufficient distance away from the site boundary and sensitive receptors. Due to the large size of the sites, noise emissions from construction and operation activities would not be expected to cause annoyance to the public.

Water Resources

The construction and operation of the proposed facilities under the Preferred Alternative at Hanford, INEL, Pantex, and SRS would affect water resources. All facilities would be constructed outside of the 100-year, 500-year, and probable maximum flood; although the 500-year floodplain is not completely mapped at SRS, the facilities would likely be located outside the 500-year floodplain. Flooding from dam failures and flooding from a landslide resulting in river blockage would only be potentially possible at Hanford or INEL, but are not expected to occur. Wastewater discharges at all sites are expected to continue to meet National Pollutant Discharge Elimination System (NPDES) limits and reporting requirements at all sites.

Hanford Site. Surface water obtained from the Columbia River would be used as the water source for operation of the proposed facilities. The total water requirement for the Preferred Alternative at Hanford would be less than 1 percent of the Columbia River's average annual flow (3,360 m^3/s [118,700 ft^3/s]). The withdrawals are negligible in comparison with the average flow of the river and would not noticeably affect the local or regional water supply.

The wastewater discharge would account for a 98-percent increase over the No Action Alternative projected discharge. The wastewater would be treated in newly constructed sanitary, utility, and process wastewater treatment systems prior to disposal.

Idaho National Engineering Laboratory. Water requirements for the operation of the Preferred Alternative at INEL would be obtained from groundwater sources. The water requirements for the site over the projected No

Action Alternative water usage would be less than a 0.05-percent increase for construction (approximately 0.24 percent of the groundwater allotment) and a 2-percent increase for operations (approximately 9.6 percent of the groundwater allotment).

The wastewater discharged during operations would represent a 24-percent increase over the projected No Action Alternative discharge. Existing INEL treatment facilities could accommodate all the new Preferred Alternative processes and wastewater streams. If necessary, new sanitary, utility, and process wastewater treatment systems would be constructed to accommodate the increase.

Pantex Plant. Water requirements for the operation of technologies identified in the Preferred Alternative for Pantex would be obtained from groundwater resources or, if feasible, from the City of Amarillo Hollywood Road Wastewater Treatment Plant. Should only groundwater be used, the total annual site groundwater withdrawal, including that required for the Preferred Alternative in the year 2005 (the No Action base year), would be 428 million l/yr (113 million gal/yr). This represents a 72-percent increase in the projected No Action Alternative water usage. Because the projected No Action Alternative water usage reflects reductions in water use due to planned downsizing over the next few years, this quantity (No Action plus the Preferred Alternative) is considerably less than what is currently being withdrawn at Pantex (836 million l/yr [221 million gal/yr]). Pantex's groundwater usage would still contribute to the overall declining water levels of the Ogallala Aquifer.

Total estimated wastewater discharge for the Preferred Alternative (283 million l/yr [74.8 million gal/yr]) at Pantex would result in a 100-percent increase in the projected No Action Alternative discharge. If necessary, new sanitary, utility, and process wastewater treatment systems would be constructed to accommodate the increase.

Savannah River Site. Water requirements during operation of the Preferred Alternative would be obtained from existing or new well fields at SRS. The Preferred Alternative water requirements for the site would be a 3.7-percent increase over projected No Action Alternative groundwater usage. Suitable groundwater from the deep aquifers at the site is abundant, and aquifer depletion is not a problem.

The Preferred Alternative wastewater discharge to the river would be less than 5 percent of the minimum flow of Fourmile Branch (0.16 m^3/s [5.7 ft^3/s]), and less than 0.003 percent of the Savannah River average flow (283 m^3/s [9,990 ft^3/s]). SRS treatment facilities could accommodate all the new processes and wastewater streams if a new facility is built for tritium supply and recycling operations as planned. If necessary, new sanitary, utility, and process wastewater treatment systems would be constructed to accommodate the increase.

Geology and Soils

The construction of the potential facilities under the Preferred Alternative would involve some ground disturbing activities at Hanford, INEL, Pantex, and SRS (see discussion under Land Resources). Ground disturbance increases the potential for soil erosion. The key factors affecting the erosion potential of a site are the amount of disturbed land and the amount of annual precipitation. The potential for soil erosion at Hanford, INEL, and Pantex is slight because of low precipitation. Since SRS receives more precipitation, the potential for erosion is considered moderate. The amount of soil loss would depend on factors such as the frequency and severity of precipitation events; wind velocities; and the area, location, and duration of soil disturbance.

During operation, improvements to buildings, roads, and landscaping would considerably reduce the erosion potential. Erosion from stormwater runoff and wind could occasionally occur during operation of the facilities. Beyond increased erosion potential, no direct or indirect effects on geologic resources are anticipated.

Biological Resources

Hanford Site. Plutonium materials would continue to be stored at the PFP in the 200 West Area. Construction of the pit disassembly/conversion, Pu conversion, ceramic immobilization, and MOX facilities would be located on vacant land in the 200 Area adjacent to 200 East and would affect animal populations. Less mobile animals within the project area, such as reptiles and small mammals, would not be expected to survive. Noise from construction and operation activities would cause larger mammals and birds in the construction area and adjacent areas to move to similar habitat nearby. Nests and young animals living within the assumed sites may not survive. The sites would be surveyed as necessary for the nests of migratory birds before construction. Areas disturbed by construction, but not occupied by facility structures, would be of minimal value to wildlife because they would be maintained as landscaped areas.

Wetlands or aquatic resources would not be affected since no wetlands or surface water bodies exist near the assumed facilities locations. During both construction and operation, water would be withdrawn from the Columbia River through an existing intake structure, and wastewater would be discharged to evaporation/infiltration ponds. Wetlands or aquatic resources bordering the river would not be affected because the volume of water required represents a small percentage of the flow of the river.

It is unlikely that federally listed threatened and endangered species would be affected by construction and operation of the four disposition facilities, but sagebrush habitat would be disturbed. The sagebrush community is an important nesting/breeding and foraging habitat for several State-listed and candidate species, such as the ferruginous hawk, loggerhead shrike, western burrowing owl, pygmy rabbit, western sage grouse, and sage thrasher. Pre-activity surveys would be conducted as appropriate before construction to determine the occurrence of plant species or animal species and habitat in the area to be disturbed. DOE would also consult with Federal and State agencies pursuant to the *Endangered Species Act* (ESA) and other statutes as appropriate.

Idaho National Engineering Laboratory. Plutonium materials would continue to be stored at the ICPP and at ANL-W in the ZPPR and FMF vaults. Construction of the pit disassembly/conversion and MOX facilities on undeveloped land within or near the ICPP security area would affect animal populations. Less mobile animals within the project area, such as reptiles and small mammals, would be expected not to survive. Noise from construction and operation activities would cause larger mammals and birds in the construction area and adjacent areas to move to similar habitat nearby. Nests and young animals living with the assumed sites may not survive. The sites would be surveyed as necessary for the nests of migratory birds before construction. Areas disturbed by construction, but not occupied by facility structures, would be of minimal value to wildlife because they would be maintained as landscaped areas.

Wetlands and aquatic resources associated with the nearest surface water body, the Big Lost River, are located 1.6 km (1 mi) from the facility location. Due to the lack of wetlands or aquatic resources at the assumed facility locations, these resources would not be affected by construction or operation of the two facilities.

It is unlikely that federally threatened or endangered species would be affected by construction of the two disposition facilities, but several State-listed species may be affected. Burrows and foraging habitat for the pygmy rabbit would be lost. Bat species such as the Townsend's western big-eared bat may roost in caves and forage through the assumed site. One State-listed sensitive plant species could potentially be affected by construction of the facility. The plant species, tree-like oxytheca, has been collected at eight sites on INEL and at only two other sites in Idaho. If present, individual plants of this species could be destroyed during land clearing activities. Preactivity surveys would be conducted as appropriate before construction to determine the occurrence of these species and habitat in the area to be disturbed. DOE would also consult with Federal and State agencies pursuant to the ESA and other statutes as appropriate. No impacts to threatened and endangered species are expected due to facility operation.

Pantex Plant. Upgrading the existing storage Pu storage facility at Pantex would cause minimal disturbance to biological resources because all activities, including some new construction, would take place within the developed area. Noise associated with construction could cause some temporary disturbance to wildlife, but this impact would be minimal since animals living adjacent to the developed area have already adapted to its presence. Impacts to wetlands and aquatic resources would not occur since these resources do not exist in the upgrade area. Since the upgrade would take place within a developed area, impacts to threatened and endangered species would not be expected.

Both the pit disassembly/conversion facility location in Zone 12 and the MOX fuel fabrication facility location in Zone 11 lack natural vegetation. Disturbance of wildlife would be limited due to the existing disturbed nature of the assumed locations; however, small mammals and some birds and reptiles could be displaced by construction. Since the area around both locations does not contain any wetlands or aquatic resources, these resources would not be affected by construction of the facility. During operation, wastewater would be discharged to site playas through NPDES-regulated outfalls. The additional wastewater could lead to minor increases in open water near the outfalls, as well as changes in plant species composition. It is unlikely that federally listed threatened or endangered species would be affected by construction or operation of the facilities. Although the assumed sites have been disturbed, it is possible that the State-listed Texas horned lizard could be present. Before construction, preactivity surveys would be conducted, as appropriate to determine the presence of any special status species and habitat on the proposed site; DOE would also consult with Federal and State agencies pursuant to the ESA and other statutes as appropriate.

Savannah River Site. No additional impacts on biological resources are expected from modifying the APSF in F-Area to accommodate the storage of RFETS non-pit Pu material in addition to SRS non-pit Pu material because the modification would only use previously disturbed land.

For the pit disassembly/conversion, Pu conversion, and ceramic immobilization facilities, impacts to terrestrial resources would be minimal because the F-Area is one of the highly developed industrial areas of the SRS. Noise associated with construction could cause some temporary disturbance to wildlife, but this impact would be minimal since animals living adjacent to the F-Area have already adapted to similar disturbances. There would be no direct impacts to wetlands or aquatic resources from construction of the facility. Secondary impacts from stormwater runoff would be controlled by implementation of a soil erosion and sediment control plan. Operational impacts to wetlands and aquatic resources would be minimal since there would be relatively small increases in treated wastewater and storm water that would be discharged via NPDES-permitted outflows. Impacts from construction and operation of the three disposition facilities would not be expected to affect threatened and endangered species due to the developed nature of the assumed facility locations. Although suitable foraging habitat for the red-cockaded woodpecker exists in the area, the woodpecker colonies are located far enough from the facilities so that this species would not be directly affected by these facilities. Before committing construction resources, DOE would consult with Federal and State agencies pursuant to the ESA and other statutes as appropriate.

Construction of the MOX facility north of the P-Reactor Area on the east side of SRS Route F would affect animal populations. Less mobile animals within the project area, such as reptiles and small mammals, would not be expected to survive. Noise from construction and operation activities would cause larger mammals and birds in the construction area and adjacent areas to move to similar habitat nearby. Nests and young animals living with the assumed sites may not survive. The sites would be surveyed as necessary for the nests of migratory birds before construction. Areas disturbed by construction, but not occupied by facility structures, would be of minimal value to wildlife because they would be maintained as landscaped areas.

Since the majority of the assumed MOX fuel fabrication facility site is upland, the facility could be located to avoid direct impacts to wetlands. Wastewater discharge from construction and operation would be minimal and would not be expected to affect wetlands associated with the receiving stream. Stormwater runoff during construction could cause temporary water quality changes in local tributaries to Par Pond. During operation, nonhazardous wastewater flow increases are not expected to impact stream hydrology or aquatic resources. All discharges would be required to meet NPDES permit regulations.

It is unlikely that federally listed threatened or endangered species would be affected by construction or operation of a MOX fuel fabrication facility. Although bald eagles have been sighted in the vicinity of the assumed facility location, it is highly unlikely that construction and operation of the MOX fuel fabrication facility would affect this species. Although suitable foraging habitat for the red-cockaded woodpecker exists in the area, the woodpecker colonies are located far enough from the facilities so that this species would not be directly affected by the MOX facility. Before construction, preactivity surveys would be conducted as appropriate to determine the presence of any special status species and habitat on the proposed site; DOE would consult with Federal and State agencies pursuant to the ESA and other statutes as appropriate.

Cultural and Paleontological Resources

The impacts to cultural and paleontological resources are closely related to the amount of land disturbed. The land-use impacts associated with construction and operation of the Preferred Alternative actions at Hanford, INEL, Pantex, and SRS are discussed under Land Resources. Because most of the locations proposed have been previously disturbed, it is unlikely that they would contain subsurface prehistoric or historic archaeological deposits. Some paleontological remains may be encountered during construction. Operations would not have additional impacts on historic, prehistoric, or paleontological resources, but there may be visual or auditory intrusions to Native American resources.

Hanford Site. Plutonium materials would continue to be stored at the PFP in the 200 West Area. The pit disassembly/conversion, Pu conversion, ceramic immobilization, and MOX facilities would be located on vacant land in the 200 Area adjacent to 200 East. Although no archeological resources have been identified during surveys conducted in the adjacent 200 Areas, some may exist in the facility locations. Any such sites would be identified through compliance with Sections 106 and 110 of the *National Historic Preservation Act* of 1966 (NHPA). Any identified sites may be affected by facility construction. Operation would not result in additional impacts.

Although all of Hanford is considered sacred land by some Native American groups, no areas of great cultural significance have been identified close to the 200 Area. Resources may be identified through facility-specific consultation. Impacts from construction and operation may include reduced access to traditional use areas or visual or auditory intrusion into sacred or ceremonial space.

Pliocene and Pleistocene fossil remains have been discovered at Hanford. Although none have been recorded in the facility locations, they may exist. These resources may be affected by ground disturbing construction. Operations would not have additional impacts on paleontological resources.

Idaho National Engineering Laboratory. Plutonium materials would continue to be stored at the ICPP and the ZPPR and FMF vaults in ANL-W. The pit disassembly/conversion and MOX facilities would be located on undeveloped land within or near the ICPP security area. The pit disassembly/conversion facility would be sited in a location previously approved for the construction of the Special Isotope Separation Project. A surface survey of this area identified no prehistoric or historic sites. Although it is possible, the ICPP is unlikely to contain intact subsurface cultural deposits, due to prior ground disturbance and environmental setting. INEL has a contingency plan in place should any archeological remains be discovered during construction. Two historic sites exist adjacent to the ICPP, one historic can scatter lies across the Big Lost River to the northeast, and one abandoned homestead is to the east. The can scatter is not considered eligible for National Register of Historic Places (NRHP) listing, and the homestead has been fenced off for protection. Construction and operation are not expected to affect either site.

Native American resources may be affected by the proposed facilities. Facility construction and operation may have visual or auditory impacts on traditional use areas or sacred sites. Resources may be identified through consultation with the interested tribes.

Some paleontological remains may be encountered during construction. The ICPP lies on alluvial gravels associated with the Big Lost River floodplain, which have produced fossilized remains. Operation would not have an effect on paleontological resources.

Pantex Plant. Modifications of Buildings 12-66 and 12-82 in Zone 12 South to accommodate the long-term storage of Pantex pits and RFETS pits are not considered NRHP eligible based on an evaluation of World War II Era structures at Pantex. However determinations of NRHP-eligible Cold War Era structures have not been completed, and some structures in Zone 12 may be determined eligible on that basis. Zone 12 is also the potential location for the pit disassembly/conversion facility. Because Zone 12 South is developed, disturbed, and removed from water sources, it is unlikely to contain subsurface prehistoric or historic archeological deposits, even on lands used for equipment laydown or construction parking. No impacts to prehistoric or historic resources are expected to result from the construction or operation of these facilities.

Areas that would be disturbed in Zone 11 for the MOX fuel fabrication facility have not been systemically surveyed for archaeological or paleontological resources. Before construction, additional survey work may be necessary under Section 106 of the NHPA. Because Zone 11 is disturbed, it is unlikely to contain subsurface prehistoric or historic archeological deposits. Should any subsurface remains be discovered during construction, appropriate mitigation, documentation, and/or preservation measures would be conducted as necessary. Operations would not have additional impacts to archeological resources as it does not result in additional ground disturbance. Facility construction may have an impact on historic structures at Pantex. The original buildings in Zone 11 were constructed between 1942 and 1945 to produce general purpose bombs. Zone 11 contains buildings, ramps, and landscape features that clearly illustrate the historic layout of a World War II bomb manufacturing line. Only two buildings within Zone 11 have been determined ineligible for listing on the NRHP. Construction may obscure the spatial relationship between these buildings, thereby compromising their historic significance. Operation of the facility is not expected to affect historic structures.

The Department has recently initiated consultation with Native American groups that have expressed interest in Pantex lands. To date, no Native American resources have been identified within Zones 11 and 12. Resources may be identified through additional consultation. Although no mortuary remains have been discovered at Pantex to date, it is possible that some exist within land to be disturbed by development. Burials are considered important Native American resources. Construction and operation could affect traditionally used plant and animal species.

The surficial geology of the Pantex area consists of silts, clays, and sands of the Blackwater Draw Formation. In other areas of the High Plains, this formation has produced Late Pleistocene vertebrate remains including woolly mammoth, bison, and camel, sometimes in context with archaeological remains. The land to be disturbed during construction may contain some fossilized remains. Operation would not have an affect on paleontological resources.

Savannah River Site. The Actinide Packaging and Storage Facility in F-Area would be modified to accommodate the storage of SRS non-pit Pu material and RFETS non-pit Pu material for the storage Preferred Alternative. Vacant land in the F-Area would be used for the pit disassembly/conversion, Pu conversion, and ceramic immobilization facilities. Portions of the F-Area have been surveyed and contain sites potentially eligible for the NRHP. Additional surveys would be conducted in any unsurveyed areas to be disturbed by construction. Site types known to occur at SRS include remains of prehistoric base camps, quarries, and workshops. Historic resources include remains of farmsteads, cemeteries, churches, and schools. Resources such as these may be affected by new facility construction, but not operation.

The MOX fuel fabrication facility would be located on undeveloped land approximately 1.6 km (1 mi) north of the P-Reactor Area on the east side of SRS Route F. To date, seven prehistoric sites have been located within 0.5 km (0.3 mi) of this area, so the potential for archaeological sites is moderate to high, and some NRHP-eligible resources may occur within the acreages that would be disturbed by construction. Prehistoric site types that may occur at SRS include villages, base camps, limited activity sites, quarries, and workshops. Historic site types that may occur at SRS include farmsteads, tenant dwellings, mills, plantations and slave quarters, rice farming dikes, cattle pens, dams, towns, churches, cemeteries, trash scatters, and roads.

Some Native American resources may be affected by construction and operation of the facilities. Resources such as prehistoric sites, cemeteries, isolated burials, and traditional plants could be affected by construction. Facility operation could result in reduced access to traditional use areas or sacred space. Visual or auditory intrusions to the areas may also result from the proposed facilities. These resources would be identified through consultation with the potentially affected tribes.

Some paleontological remains may occur on this acreage, but impacts during construction would be considered negligible because fossil assemblages known to occur at SRS are of low research value. No additional impacts are expected to paleontological resources during operation since no additional ground disturbance is expected.

Socioeconomics

At Hanford, INEL, Pantex, and SRS the primary impact of the Preferred Alternative would be to increase regional employment and income. There would be some increase in demand for community services and housing at each of the sites as a result of in-migrating population. However, the available housing and existing community infrastructure would be able to accommodate these small population increases. Construction and operation of the proposed facilities would increase traffic flow and cause a potential decline in the level of service on some road segments at all sites except Hanford. At RFETS, phaseout of Pu storage would result in the loss of approximately 2,200 direct jobs. Compared to the total employment in the area, the loss of these jobs and the impacts to the regional economy would not be severe.

Hanford Site. Plutonium materials would continue to be stored at the PFP in the 200 West Area, and there would be no impact on the site workforce. Construction of the pit disassembly/conversion, Pu conversion, ceramic immobilization, and MOX facilities would continue through the year 2013, and there would be sufficient available labor within the region to fulfill construction workforce requirements. Economic impacts from construction would peak in 2010, during construction of the ceramic immobilization facility. Total regional economic area (REA) employment would increase by 2001 due to construction of the ceramic immobilization facility. However, during this same period, the other three disposition facilities would already be fully operational, generating approximately 7,500 additional jobs in the REA.

In the year 2003, the pit disassembly/conversion and MOX facilities would be the first disposition alternative facilities to become fully operational. Pu conversion would begin in 2006, and the ceramic immobilization operations would begin in 2013. The operational workforce would increase beginning in the year 2003 and peak in the year 2013 when all of the disposition facilities would become fully operational. Total direct employment would reach approximately 3,100 in 2013. Total REA employment would increase by approximately 10,400, and unemployment would decrease from 9.1 to 7.1 percent. The per capita income would increase by 2 percent.

In-migration to fulfill specialized direct job requirements would lead to a population increase of about 1 percent in the ROI. The additional population would increase the demand for community services by approximately 1 percent. Demand for housing would also increase, but the impact on the local markets would be minimal.

Construction and operation workers at Hanford would generate 1,920 and 5,900 additional vehicle trips per day on the local roads, respectively. The level of service would not change due to the additional traffic generated during construction. Operations would cause a drop in level of service from B to C on Washington State Route 240 from Washington State Route 24 to Washington State Route 224.

Idaho National Engineering Laboratory. Plutonium materials would continue to be stored at ICPP and ZPPR, and in FMF vaults at ANL-W. No additional workforce would be required for continuation of the storage mission at INEL. Construction of the pit disassembly/conversion and MOX facilities would take place concurrently and continue through the year 2003. Some in-migration would take place both during construction and operation to fill specialized job requirements. Direct employment during peak construction would reach 660 in 1999 and total 1,330 during the first year of full operation in 2003. Total REA employment would increase by approximately 1,200 during construction and by approximately 6,000 during operations. Unemployment would decrease from 5.4 percent to 4.8 percent during peak construction and fall further to 2.4 percent during operation. The per capita income would increase by less than 0.4 percent during construction and by about 1.4 percent during operations.

In-migration to fulfill direct job requirements for both construction and operations would lead to a population increase of less than 1 percent in the ROI. The additional population would increase demand for community services by less than 1 percent during both construction and operations. Demand for housing would also increase, but, the impact on the local markets would be minimal.

Construction and operation workers at INEL would generate 1,267 and 2,554 additional vehicle trips per day on local roads, respectively. The level of service would not change due to additional traffic generated during construction. Operations would cause a drop in level of service from D to E on US 20 from US 26/91 at Idaho Falls to US 26 East. Operations would also cause a drop in level of service from B to C on US 20/26 from US 26 East to Idaho State Route 22/33.

Pantex Plant. Buildings 12-66 and 12-82 would be modified to accommodate the long-term storage of Pantex pits and RFETS pits for the storage Preferred Alternative. Additional workers would be required for construction and operation of the modified storage facilities. Construction of the pit disassembly/conversion and MOX fabrication facilities would take place concurrently and continue through 2003, when full operations would commence. Because the construction of the disposition facilities would require a larger workforce than would modification of the storage facilities, peak construction impacts would occur in 1999. Peak operation impacts would occur in 2005, when all three facilities would be fully operational. Total direct construction employment during peak construction would reach 660 in 1999, and direct operation employment would reach 1,420 in 2005, when all three facilities would be fully operational. Total REA employment would increase by 1,192 during peak construction and by 6,404 during operations. Unemployment would decrease from 4.8 percent to 4.3 percent during peak construction and fall further to 3.0 percent during operations. The per capita income would increase about 0.3 percent during construction and by 0.5 percent during operations.

In-migration to fulfill direct job requirements for both construction and operations would lead to a population increase of 0.1 percent during construction and about 2 percent during operation. The increase in demand for community services during construction and operation would be minimal. Demand for housing would also increase, but, the impact on the local markets would be minimal.

Construction and operation workers at Pantex would generate 1,267 and 2,726 additional vehicle trips per day on local roads, respectively. The level of service would not change due to additional traffic generated during construction. Operations would cause a drop in level of service from A to B on Farm-to-Market 683 from US 60 to Farm-to-Market 293 and on Farm-to-Market 2373 from I-40 to US 60.

Savannah River Site. Under the Preferred Alternative, the Actinide Packaging and Storage Facility in the F-area would be modified to accommodate the long-term storage of the SRS non-pit Pu material and RFETS non-pit Pu material. The modification activities would employ workers from the current workforce, while operation of the expanded storage facility would require some additional workers. Construction of the pit disassembly/conversion, Pu conversion, MOX fuel fabrication, and the ceramic immobilization facilities would continue until 2013, when all of the facilities would become operational. There would be sufficient available labor in the region to fulfill the construction workforce requirements. Economic impacts from construction would peak in 2010, during construction of the ceramic immobilization facility. Total REA employment would increase by 1,793 due to construction of the ceramic immobilization facility. However, during this same period, the other three disposition facilities would already be operating and generating an additional 6,936 jobs in the REA. Peak economic impacts would occur in 2013, when all of the storage and disposition facilities would be fully operational. Total employment in the region would increase by 9,482, and unemployment would decrease to 4.5 percent. Regional per capita income would increase by about 1.6 percent.

Because of the demand for in-migrating workers to fill specialized employment requirements, the ROI population would increase by 0.9 percent. Demand for community services would increase about 1 percent or less. The increase in demand for housing would be too small to affect the market.

Construction and operation workers at SRS would generate 1,920 and 6,150 additional vehicle trips per day on local roads, respectively. Construction would cause a drop in level of service from E to F on South Carolina State Route 19 from US 1/78 at Aiken to US 278. Operations would not significantly impact local roads.

Public and Occupational Health and Safety

Normal Operations. The human health impacts from the radiological and hazardous chemical releases during facility normal operations associated with the storage and disposition Preferred Alternative actions were analyzed at each of the DOE sites. The impact of the Preferred Alternative actions were then combined to obtain the "total impact." Total impact for each receptor/impact parameter is the summation of each facility, action, process, or technology for each of the operational campaigns (the number of years required to complete Pu disposition). Under normal radiological operations, the annual incremental dose to the maximally exposed individual (MEI) ranges from 2.7×10^{-4} millirem (mrem)/yr at INEL to 4.1×10^{-3} mrem/yr at SRS. All doses, when added to No Action, are within the radiological limits specified in NESHAPS (40 CFR 61, Subpart H) and DOE Order 5400.5. The annual incremental dose to the population within 80 km (50 mi) from the Preferred Alternative ranges from 4.2×10^{-3} person-rem/yr at INEL to 0.22 person-rem/yr at SRS. For DOE activities, proposed 10 CFR 834 (See 58 FR 1628) would generally limit the potential annual population dose to 100 person-rem from all pathways combined, and would require an As Low As Reasonably Achievable Program. When the contribution from the Preferred Alternative is combined with the No Action population dose for each of the sites, the total dose is well within the proposed 10 CFR 834. The dose assessments of the involved worker for storage and disposition facilities are within DOE radiological limits and administrative control levels. The incremental latent cancer fatalities to the involved workforce statistically estimated from these doses attributed to the Preferred Alternative range from 0.48 at INEL to 1.32 at SRS for the entire campaign (estimates based on the *1990 Recommendations of the International Commission of Radiological Protection*).

Facility Accidents. A set of potential accidents was postulated for each component of the Preferred Alternative. For each DOE site subject to multiple storage and disposition actions (Hanford, INEL, Pantex, and SRS), this includes a set of accidents for the storage option coupled with the combination of preferred disposition technologies assumed for the analysis. For the Existing LWR Alternative, a Probabilistic Risk Assessment (PRA) approach was applied to determine the effects of operating an existing LWR with a MOX core. The incremental effects are described below.

One measure of impact calculated from modeled accident scenarios is expected risk, the summation of risk (the product of accident occurrence probability and consequence) for the accident spectrum modeled for each component of the Preferred Alternative. These expected risks were aggregated for the Preferred Alternative for the following impact receptors: a worker located 1,000 m (3,280 ft) from the accident release point; the maximum hypothetical offsite individual located at the site boundary; and the population located within 80 km

(50 mi) of the accident release point. Aggregated expected risk estimates of cancer fatality(s) for each assumed campaign under the Preferred Alternative range from: 1.3×10^{-6} at INEL to 1.5×10^{-5} at Pantex; 1.4×10^{-8} at INEL to 6.0×10^{-6} at Pantex; and 3.0×10^{-5} at INEL to 9.1×10^{-4} at Pantex; respectively for these impact receptors. The Y–12 upgrade at ORR under the Preferred Alternative could reduce the expected risk of cancer fatalities for the design basis accidents analyzed in the Y–12 EA to 5.1×10^{-7}, 7.4×10^{-6}, and 5.7×10^{-8} per year for the 80-km (50-mi) offsite population, MEI, and noninvolved worker, respectively by meeting the performance goal for a moderate hazard facility of Performance Category 3 as prescribed in DOE Order 5480.28, *Natural Phenomena Hazards Mitigation*.

The evaluated accident scenario with the highest risk to the public at the DOE sites under the Preferred Alternative (a fire on the loading dock of the MOX fuel fabrication facility) would result in an estimated risk of 5.2×10^{-5}, 1.6×10^{-5}, 1.8×10^{-5}, and 5.2×10^{-5} cancer fatalities over the assumed MOX fuel fabrication campaign at Hanford, INEL, Pantex, and SRS, respectively.

Under the Preferred Alternative, the use of existing LWRs is being pursed for the disposition of surplus plutonium through the use of MOX fuel in place of UO_2. An important question is whether the use of MOX fuel changes the safety envelope of UO_2 fueled reactors documented in Safety Analysis Reports, PRAs, and NUREG-1150 (*Severe Accident Risks: An Assessment for Five U.S. Nuclear Power Plants*). Related reactor safety issues are addressed in a recent report by the National Academy of Sciences (*Management and Disposition of Excess Weapons Plutonium Reactor-Related Options*). The report indicates that the potential influences on safety of the use of MOX fuel in LWRs has been extensively studied in the United States in the 1970s (*Final Generic Environmental Impact Statement on the Use of Recycled Plutonium in Mixed Oxide Fuel in Light Water Cooled Reactors*, NUREG-0002). These influences have also been extensively studied in Europe, Japan and Russia. Regarding effects of MOX on accident probabilities, the National Academy of Sciences report states, "... no important overall adverse impact of MOX use on the accident probabilities of the LWRs involved will occur; if there are adequate reactivity and thermal margins in the fuel, as licensing review should ensure, the main remaining determinants of accident probabilities will involve factors not related to fuel composition and hence unaffected by the use of MOX rather than LEU fuel." Regarding the effects of MOX on accident consequences, the report states, "... it seems unlikely that the switch from uranium-based fuel could worsen the consequences of a postulated (and very improbable) severe accident in a LWR by more than 10 to 20 percent. The influence on the consequences of less severe accidents, which probably dominate the spectrum value of population exposure per reactor-year of operation would be even smaller, because less severe accidents are unlikely to mobilize any significant quantity of plutonium at all."

The incremental effects of utilizing MOX fuel in a commercial reactor in place of UO_2 were derived from a quantitative analysis of several typical severe accident scenarios for MOX and UO_2 using the MACCS computer code and generic population and meteorology data. The analysis only considers highly unlikely severe accidents where sufficient damage would occur to cause the release of Pu or uranium. The risks of severe accidents were found to be in the range of plus 8 to minus 7 percent, compared to UO_2 fuel, depending on the accident release scenario. The incremental risk of cancer fatalities to a generic offsite population located within 80 km (50 mi) of the severe accident release point would range from -2.0×10^{-4} to 3.0×10^{-5} per year for the accident release scenarios analyzed.[18] These preliminary results would be re-examined for licensing purposes and subsequent NEPA review. More detailed safety analyses would be performed using both up-to-date calculations of radionuclide inventories for different fuel compositions and irradiation histories, and population-exposure models for sensitivity changes in those inventories resulting from the use of weapons-grade Pu in the fuel.

[18] Accidents severe enough to cause a release of Pu or HEU involve combinations of events that are highly unlikely. Estimates and analyses presented in Chapter 4 and summarized in Table 2.5–3 indicate a range of latent cancer fatalities of 5.9×10^3 to 7.3×10^3 and risk per year of 0.15 to 0.16.

Natural Phenomena. Under the Preferred Alternative, HEU would continue to be stored at the Y–12 Plant at ORR in existing facilities that would be upgraded. The majority of the HEU would be housed in upgraded facilities currently used for HEU storage. The remaining HEU would be stored in facilities that were formerly used for material processing but are currently being modified and converted into storage areas. Modifications to existing buildings would make the facilities suitable for long-term storage and consist primarily of those upgrades required to meet natural phenomena requirements (including earthquakes and tornadoes) as documented in *Natural Phenomena Upgrade of the Downsized/Consolidated Oak Ridge Uranium/Lithium Plant Facilities* (Y/EN-5080, 1994). The Y–12 storage buildings would be upgraded to meet the performance goal for a moderate hazard facility of Performance Category 3 in DOE Order 5480.28, *Natural Phenomena Hazards Mitigation*. In a Performance Category 3 facility, radioactive or toxic materials are present in significant quantities. Design considerations for this category are to limit facility damage so that hazardous materials can be controlled and confined, occupants can be protected, and functions of the facility can continue without interruption. A performance goal for Performance Category 3 is a hazard exceedance frequency of 1.0×10^{-4} per year (DOE Order 5480.28). Meeting this performance goal would reduce the expected risk for the design basis accidents analyzed in the Y–12 EA (for example, Building 9212) by approximately 80 percent, resulting in a latent cancer fatality risk of 5.1×10^{-7} to the MEI and 5.7×10^{-8} to a noninvolved worker, and potential latent cancer fatalities of 7.4×10^{-6} for the 80-km (50-mi) offsite population.

At SRS, F-Canyon facilities could be used for the immobilization of surplus Pu using the can-in-canister variant under the Preferred Alternative. The earthquake accident analysis in the IMNM EIS determined that the F-Canyon facilities are structurally sound. Since that time, DOE has prepared a *Supplemental Analysis of Seismic Activity on F-Canyon* (August 1996). Based on the evaluation, an earthquake that could occur about once every 8,000 years could cause a level of structural damage to F-Canyon similar to the level of damage attributed to the earthquake considered in the IMNM EIS. Thus, the capability of F-Canyon to survive an earthquake more severe than that evaluated in the EIS, in combination with the fact that the likelihood of this level of damage was less than assumed in the EIS (1 per 8,000 years compared to 1 per 5,000 years), indicates that F-Canyon is seismically safe, or safer, than indicated in the IMNM EIS.

Waste Management

There is no spent nuclear fuel or HLW associated with construction or operation of Preferred Alternative facilities, but the ceramic immobilization facility would generate as its product output a stabilized ceramic form spiked with cesium radionuclides. (For immobilization using vitrification, a stable glass form of Pu and HLW would be generated.) Storage of this immobilized product would be provided until disposal in a geologic repository pursuant to the NWPA.[19] Each of the facilities under the Preferred Alternative have as part of their conceptual design waste management facilities that would treat and package all waste generated into forms that would enable long-term storage and/or disposal in accordance with the regulatory requirements of *Resource Conservation and Recovery Act* (RCRA), and other applicable statutes. Under the Preferred Alternative, the waste management infrastructure of the individual facilities would be integrated into a single waste management infrastructure to include maximum use of existing and planned site waste management facilities. Depending in part on decisions in the waste-type specific RODs for the Waste Management PEIS, wastes could be treated, and (depending on the type of waste) disposed of, onsite or at regionalized or centralized DOE sites. The treatment level and potential disposal of TRU and mixed TRU waste at the Waste Isolation Pilot Plant (WIPP) will depend on decisions in the ROD for the *Supplemental Environmental Impact Statement for the Waste Isolation Pilot Plant Disposal Phase*. For the purposes of analyses only, this PEIS assumes that transuranic (TRU) and TRU mixed waste would be treated onsite to the current planning-basis Waste Isolation Pilot Plant (WIPP) Waste

[19] Pursuant to the *Nuclear Waste Policy Act*, DOE is currently characterizing the Yucca Mountain Site as a potential repository for spent nuclear fuel and HLW. Legislative clarification, or a determination by the Nuclear Regulatory Commission that the immobilized Pu should be isolated as HLW, may be required before the material could be placed in Yucca Mountain should DOE and the President recommend, and Congress approve, its operation. No radionuclides that are RCRA wastes would be used for immobilization so the immobilized product would be consistent with the repository's waste acceptance criteria.

Acceptance Criteria, and shipped to WIPP for disposal. This PEIS also assumes that hazardous waste, low-level waste (LLW), and mixed LLW would be treated and disposed of in accordance with current site practice.

Construction and operation of the proposed facilities would affect existing waste management activities at each of the sites analyzed, increasing the generation of TRU, low-level, mixed, hazardous, and nonhazardous wastes. Wastes generated during construction would consist of wastewater and hazardous and solid nonhazardous wastes. Wastewater and solid nonhazardous wastes would be disposed of as part of the construction project by the contractor, and the hazardous wastes would be treated onsite or shipped offsite, to a commercial RCRA-permitted treatment facility. After treatment, the waste would be disposed of off-site in a commercial RCRA-permitted disposal facility. No radioactive or hazardous soil contamination is expected to be generated during construction. However, if any were generated, it would be managed in accordance with site practice and all applicable Federal and State regulations.

Hanford Site. Under the Preferred Alternative approximately 78.2 m^3 (20,660 gal) of liquid and 750 m^3 (981 yd^3) of solid TRU waste would require treatment, and packaging to meet the current planning-basis WIPP Waste Acceptance Criteria or an alternate treatment level. An estimated 200 m^3 (262 yd^3) of solid mixed TRU waste would be managed and treated as necessary in accordance with the Hanford Tri-Party Agreement to meet the WIPP Waste Acceptance Criteria or an alternate treatment level. Depending on decisions made in the ROD for the *Supplemental Environmental Impact Statement for the Waste Isolation Pilot Plant Disposal Phase*, 109 additional truck shipments per year or, if applicable, 54 regular train shipments per year, or 18 dedicated train shipments per year would be required to transport the TRU and mixed TRU waste to WIPP.

Approximately 70.4 m^3 (18,590 gal) of liquid and 2,010 m^3 (2,630 yd^3) of solid LLW would require treatment, processing, and packaging to meet the waste acceptance criteria of the 200-Area LLW Burial Grounds. After treatment and volume reduction, 2,010 m^3 (2,630 yd^3) of solid LLW would require disposal. Assuming a land usage of factor of 3,400 m^3/ha (1,800 yd^3/acre), this would require 0.6 ha/yr (1.5 acres/yr) of LLW disposal area. The ultimate disposal of LLW will be in accordance with the ROD for the Waste Management PEIS.

Roughly 1.2 m^3 (320 gal) of liquid and 231 m^3 (302 yd^3) of solid mixed LLW would be treated and disposed of in accordance with the Hanford Tri-Party Agreement. The 46 m^3 (12,150 gal) of liquid and 184 m^3 (241 yd^3) of solid hazardous wastes would be collected, treated on- or off-site, and shipped in Department of Transportation (DOT)-approved containers to an offsite commercial RCRA-permitted treatment facility. After treatment, the waste would be disposed of off-site in commercial RCRA-permitted disposal facilities.

Approximately 177,000 m^3 (46.8 million gal) of liquid nonhazardous sanitary and industrial wastewater and 170,000 m^3 (45.0 million gal) of steam plant and cooling blowdown and estimated stormwater runoff would require treatment in accordance with site practice. Depending on actual site location, expansion of existing or construction of new sanitary, utility, and process wastewater treatment facilities may be required. The 3,240 m^3 (4,240 yd^3) of solid nonhazardous wastes that is not recycled or salvageable would be shipped to the City of Richland landfill per current site practice.

Idaho National Engineering Laboratory. Under the Preferred Alternative approximately 373 m^3 (488 yd^3) of solid TRU waste would require treatment and packaging to meet the current planning-basis WIPP Waste Acceptance Criteria or an alternate treatment level. An estimated 8 m^3 (11 yd^3) of solid mixed TRU waste would be managed and treated as necessary in accordance with the INEL Site Treatment Plan to meet the current planning-basis WIPP Waste Acceptance Criteria or an alternate treatment level. Depending on decisions made in the ROD for the *Supplemental Environmental Impact Statement for the Waste Isolation Pilot Plant Disposal Phase*, 44 additional truck shipments per year or, if applicable, 22 regular train shipments per year, or 7 dedicated train shipments per year would be required to transport the TRU and mixed TRU waste to WIPP.

Approximately 8 m^3 (2,100 gal) of liquid and 255 m^3 (333 yd^3) of solid LLW would require treatment, processing, and packaging to meet the waste acceptance criteria of the Radioactive Waste Management

Complex (RWMC). Assuming a land usage of factor of 6,200 m^3/ha (3,300 yd^3/acre), the disposal of LLW would require 0.04 ha/yr (0.1 acres/yr) of LLW disposal area. The ultimate disposal of LLW will be in accordance with the ROD for the Waste Management PEIS.

Roughly 1.1 m^3 (290 gal) of liquid and 40 m^3 (52 yd^3) of solid mixed LLW would be treated and disposed of in accordance with the INEL Site Treatment Plan. The 6 m^3 (1,500 gal) of liquid and 154 m^3 (201 yd^3) of solid hazardous wastes would be collected, treated on- or off-site, and shipped in DOT-approved containers to an offsite commercial RCRA-permitted treatment facility. After treatment, the waste would be disposed of off-site in commercial RCRA-permitted disposal facilities.

Approximately 129,000 m^3 (34.0 million gal) of liquid nonhazardous sanitary, industrial, and other process wastewater would require treatment in accordance with site practice. Depending on actual site location, expansion of existing or construction of new sanitary, utility, and process wastewater treatment facilities may be required. The 253 m^3 (331 yd^3) of solid nonhazardous wastes that is not recycled or salvageable would be shipped to the onsite landfill per current site practice.

Pantex Plant. Under the Preferred Alternative approximately 374 m^3 (489 yd^3) of solid TRU waste would require treatment and packaging to meet the current planning-basis WIPP Waste Acceptance Criteria or an alternate treatment level. An estimated 8 m^3 (11 yd^3) of solid mixed TRU waste would be managed and treated as necessary in accordance with the *Pantex Plant Federal Facility Compliance Act Site Treatment Plan/Compliance Plan* to meet the WIPP Waste Acceptance Criteria or an alternate treatment level. Depending on decisions made in the ROD for the *Supplemental Environmental Impact Statement for the Waste Isolation Pilot Plant Disposal Phase*, 44 additional truck shipments per year or, if applicable, 22 regular train shipments per year, or 7 dedicated train shipments per year would be required to transport the TRU and mixed TRU waste to WIPP.

Approximately 8 m^3 (2,100 gal) of liquid and 392 m^3 (513 yd^3) of solid LLW would require treatment, processing, and packaging to meet the waste acceptance criteria of the NTS Area 5 Radioactive Waste Management Site Waste Acceptance Criteria. After treatment and volume reduction, 324 m^3 (424 yd^3) of solid LLW would require disposal. Assuming a land usage of factor of 6,000 m^3/ha (3,200 yd^3/acre), the disposal of LLW would require 0.05 ha/yr (0.13 acres/yr) of LLW disposal area at NTS. Assuming 16.6 m^3 (21.7 yd^3) of LLW per shipment, 20 additional LLW shipments per year from Pantex to NTS would be required. The ultimate disposal of LLW will be in accordance with the ROD for the Waste Management PEIS.

Roughly 1.3 m^3 (350 gal) of liquid and 48 m^3 (63 yd^3) of solid mixed LLW would be treated and disposed of in accordance with the *Pantex Plant Federal Facility Compliance Act Site Treatment Plan/Compliance Plan*. The 7 m^3 (1,760 gal) of liquid and 155 m^3 (203 yd^3) of solid hazardous wastes would be collected, treated on- or off-site, and shipped in DOT-approved containers to an offsite commercial RCRA-permitted treatment facility. After treatment, the waste would be disposed of off-site in commercial RCRA-permitted disposal facilities.

Approximately 141,000 m^3 (37.2 million gal) of liquid nonhazardous sanitary, industrial, and other process wastewater would require treatment in accordance with site practice. Depending on site location, expansion of existing or construction of new utility and process wastewater treatment facilities may be required. The existing sanitary wastewater treatment system has adequate excess capacity to treat the additional quantity of sanitary wastewater. The 391 m^3 (511 yd^3) of solid nonhazardous wastes that is not recycled or salvageable would be shipped to the City of Amarillo landfill per current site practice.

Savannah River Site. Under the Preferred Alternative approximately 78.2 m^3 (20,660 gal) of liquid and 750 m^3 (981 yd^3) of solid TRU waste would require treatment and packaging to meet the current planning-basis WIPP Waste Acceptance Criteria or an alternate treatment level. An estimated 200 m^3 (262 yd^3) of solid mixed TRU waste would be managed and treated as necessary in accordance with the SRS Treatment Plan to meet the current planning-basis WIPP Waste Acceptance Criteria or an alternate treatment level. Depending on decisions made in the ROD for the *Supplemental Environmental Impact Statement for the Waste Isolation Pilot Plant Disposal Phase*, 109 additional truck shipments per year or, if applicable, 54 regular train shipments per year, or 18 dedicated train shipments per year would be required to transport the TRU and mixed TRU waste to WIPP.

Approximately 70.4 m^3 (18,600 gal) of liquid and 2,010 m^3 (2,630 yd^3) of solid LLW would require treatment, processing, and packaging to meet the waste acceptance criteria of the SRS E-Area Low-Level Radioactive Disposal Facility. After treatment and volume reduction, 2,010 m^3 (2,630 yd^3) of solid LLW would require disposal. Assuming a land usage of factor of 8,600 m^3/ha (4,600 yd^3/acre), this would require 0.2 ha/yr (0.5 acres/yr) of LLW disposal area. The ultimate disposal of LLW will be in accordance with the ROD for the Waste Management PEIS.

Roughly 1.2 m^3 (311 gal) of liquid and 231 m^3 (302 yd^3) of solid mixed LLW would be treated and disposed of in accordance with the SRS Site Treatment Plan. The 46 m^3 (12,070 gal) of liquid and 184 m^3 (241 yd^3) of solid hazardous wastes would be collected, treated on- or off-site, and shipped in DOT-approved containers to an offsite commercial RCRA-permitted treatment facility. After treatment, the waste would be disposed of off-site in commercial RCRA-permitted disposal facilities.

Approximately 179,000 m^3 (47.3 million gal) of liquid nonhazardous sanitary and industrial wastewater and 170,000 m^3 (45 million gal) of steam plant and cooling blowdown and estimated stormwater runoff would require treatment in accordance with site practice. Depending on actual site location, expansion of existing or construction of new utility and process wastewater treatment facilities may be required. The centralized sanitary wastewater treatment system is adequate to treat the sanitary portion. The 3,250 m^3 (4,250 yd^3) of solid nonhazardous wastes that is not recycled or salvageable would be shipped to an offsite landfill per current site practice.

Intersite Transportation

The estimated health effects from transportation of radiological materials for the Preferred Alternative actions at Hanford, INEL, Pantex, and SRS for the life of the project range from 0.193 fatalities for Pantex to 1.87 fatalities for SRS.

In addition to the activities at the DOE sites, there would be transportation of the MOX fuel from the DOE fuel fabrication site to existing LWRs. The location of the LWRs and the destination of the MOX fuel could be either the eastern or western United States. For 4,000 km (2,486 mi) there could be an additional 3.61 potential fatalities. The 3.61 potential fatalities assumes that 100 percent of the surplus Pu would be used in commercial reactors. For analysis purposes, approximately 70 percent of the surplus Pu would be used in commercial reactors under the Preferred Alternative, therefore potential fatalities could be lower.

Environmental Justice

There would be no high and adverse health or environmental impacts to any population around the sites, including low-income and minority populations, from normal operation of the Preferred Alternative actions. The alternatives would confer socioeconomic benefits to each site where storage or disposition activities would occur (except RFETS), and therefore would not lead to any environmental justice concerns.

For environmental justice impacts to occur, there must be high and adverse human health or environmental impacts that disproportionately affect minority populations or low-income populations. The public health and safety analysis shows that air emissions and hazardous chemical and radiological releases from normal operations for all storage and disposition alternatives would be within regulatory limits and that no latent cancer fatalities would result.

The public health and safety analyses also indicate that radiological releases from accidents would not result in significant adverse human health or environmental impacts. Therefore, such accidents would not have disproportionately high and adverse impacts on minority or low-income populations. For the Preferred Alternative, for accidents associated with existing LWRs using MOX fuel, the maximum risk (which includes accident probability) of latent cancer fatalities to the public within 80 km (50 mi) would be 0.10 for the 11-year Pu disposition campaign. Therefore, it is unlikely that there would be disproportionately high and adverse impacts to minority populations or low-income populations surrounding the LWRs. Any potential transportation accidents would be random events that would not disproportionately affect minority or low-income populations.

S.7 CUMULATIVE IMPACTS

Cumulative impacts are those that could result from the incremental impact of the proposed action and alternatives identified above when added to other past, present, and reasonably foreseeable future actions, regardless of what agency or person undertakes such actions. The reference condition is the No Action Alternative, which addresses the impacts of past, present, and ongoing programs. In particular, for alternatives that are proposed for DOE sites, the analysis focuses on the potential for cumulative impacts at each candidate site where other programs are reasonably anticipated.

The reasonably foreseeable future actions that have the potential to be implemented at some of the DOE sites under consideration, in addition to the long-term storage and disposition alternatives considered in the Storage and Disposition PEIS, include the following DOE programs: Waste Management (at Hanford, NTS, INEL, Pantex, ORR, SRS, RFETS, and LANL); Stockpile Stewardship and Management (at NTS, Pantex, ORR, SRS, and LANL); Tritium Supply and Recycling (at SRS); HEU Disposition (at ORR and SRS); Foreign Research Reactor Spent Nuclear Fuel (at INEL and SRS); and Spent Nuclear Fuel Management (at Hanford, INEL, and SRS).

[Text deleted.]

LONG-TERM STORAGE

Long-Term Storage Alternatives

The cumulative impact analysis, including the long-term storage alternatives and the six other reasonably foreseeable DOE programs, identified the following resource areas and issues at each site as having the potential to result in cumulative impacts:

- At Hanford, potential cumulative impacts from the maximum case alternative (Collocation) were identified for land resources, air quality, biological resources, and waste management.

- At NTS, potential cumulative impacts from the maximum case alternative (Collocation) were identified for land resources, site infrastructure, air quality, biological resources, cultural and paleontological resources, and waste management.

- At INEL, potential cumulative impacts from the maximum case alternative (Collocation) were identified for land resources, air quality, biological resources, socioeconomics (local transportation), and waste management.

- At Pantex, potential cumulative impacts from the maximum case alternative (Collocation) were identified for land resources, site infrastructure, air quality, water resources, and waste management.

- At ORR, potential cumulative impacts from the maximum case alternative (Collocation) were identified for land resources (visual quality), air quality, biological resources, cultural and paleontological resources, socioeconomics (local transportation), and waste management.

- At SRS, potential cumulative impacts from the maximum case alternative (Collocation) were identified for land resources, site infrastructure, air quality, biological resources, cultural and paleontological resources, socioeconomics (local transportation), public and occupational health and safety, and waste management.

- At RFETS, potential cumulative impacts from the maximum case alternative (Phaseout) were identified for socioeconomics.

- At LANL, no potential cumulative impacts were identified.

Preferred Alternative

The contribution to long-term storage cumulative impacts from the Preferred Alternative would be lower than the impacts identified above for the maximum case alternative at any one DOE site. Based on the cumulative impact analysis for long-term storage described above, the following resource and issue areas were identified at each site as having the potential to result in cumulative impacts:

- At Pantex, potential cumulative impacts were identified for land resources, site infrastructure, air quality, water resources, and waste management.

- At ORR, potential cumulative impacts were identified for air quality, cultural resources, local transportation, and waste management.

- At SRS, potential cumulative impacts were identified for air quality, public and occupational health and safety, and waste management.

- At RFETS, potential cumulative impacts were identified for socioeconomics.

Because the Preferred Alternative for storage at Hanford, NTS, INEL, and LANL is No Action, the storage program would not contribute to the cumulative impacts at these sites.

DISPOSITION

Disposition Alternatives

A site-specific cumulative impact analysis was not performed for all of the disposition alternatives because many of the facilities (for example, deep borehole complex and existing LWRs) do not allow site-specific cumulative impact analysis. Instead, a generic analysis that is applicable to all DOE sites was developed for these disposition alternatives. This representative scenario includes all of the common activities that would be needed for all of the disposition alternatives (construction and operation of pit disassembly/conversion and Pu conversion facilities), the common activity that would be required for the reactor alternatives (construction and operation of a MOX fuel fabrication facility), and the immobilization alternative that would generally have the largest impacts (ceramic immobilization facility). The scenario assumes that all four of the facilities would be constructed and operated concurrently at the same DOE site. Potential cumulative impacts could result from constructing and operating the pit disassembly/conversion, Pu conversion, MOX fuel fabrication, and immobilization facilities at a single DOE site.

For land resources, the construction of all four of the disposition facilities would disturb up to 191 ha (472 acres) of land during construction, of which up to 133 ha (330 acres) would be used during operations. If all four of the facilities were located at the same site, there would likely be a reduced area of disturbed land due to the sharing of land resources. Construction and operation of the disposition facilities could also result in the direct disturbance of terrestrial resources, wetlands, and threatened and endangered species.

The construction and operation of the disposition facilities could affect cultural and paleontological resources by disturbing Native American and buried paleontological materials. Constructing and operating the disposition facilities would generate employment and income increases in the region.

During normal operations of the disposition facilities, there would be both radiological and chemical releases to the environment and direct in-plant worker exposures. However, exposures are expected to be within regulated limits. To the extent possible, existing treatment systems would be used for the waste streams from the disposition facilities. If the capacity or appropriate treatment technology are not available, new treatment facilities would be built to handle the waste from the new facilities.

Preferred Alternative

Under the Preferred Alternative for disposition, Hanford and SRS are potential sites for four facilities (pit disassembly/conversion, Pu conversion, MOX fuel fabrication, and immobilization), therefore, the maximum contribution to cumulative impacts would result at these sites if all four facilities were constructed. INEL and Pantex are potential sites for two facilities (pit disassembly/conversion and MOX fuel fabrication), therefore, the maximum contribution to cumulative impacts at these sites would result if both of these facilities were constructed. Based on the cumulative impact analysis for the disposition alternatives described above, the following resource areas and issues were identified as having the potential to result in cumulative impacts:

- At Hanford, potential cumulative impacts were identified for land resources, site infrastructure, air quality, biological resources, cultural and paleontological resources, socioeconomics (local transportation), and waste management.
- At INEL, potential cumulative impacts were identified for land resources, site infrastructure, air quality, biological resources, cultural and paleontological resources, socioeconomics (local transportation), and waste management.
- At Pantex, potential cumulative impacts were identified for land resources, site infrastructure, air quality, water resources, cultural and paleontological resources, socioeconomics (local transportation), and waste management.
- At SRS, potential cumulative impacts were identified for land resources, site infrastructure, air quality, biological resources, cultural and paleontological resources, socioeconomics (local transportation), public and occupational health and safety, and waste management.

S.8 COMPARISON OF ALTERNATIVES

The environmental impacts of the storage and disposition alternatives, including the Preferred Alternative, are compared in this section. The emphasis is on those environmental resources and issues that discriminate between the alternatives and are of interest to the public. Detailed comparison tables, including each alternative and each resource and issue, are contained in Chapter 2 of the PEIS. Within this Chapter, Table 2.5–1 provides a summary of environmental impacts for the Preferred Alternative for storage; Table 2.5–2 provides a comparison of environmental impacts for the No Action and long-term storage alternatives; and Table 2.5–3 provides a comparison of environmental impacts for disposition alternatives (including the Preferred Alternative).

LONG-TERM STORAGE

Tables S.8–1 through S.8–6 present a comparison of the key environmental impacts for the long-term storage alternatives and the Preferred Alternative for storage. As discussed in Section S.2, the Preferred Alternative for storage is a combination of No Action and Upgrade Alternatives for the various DOE sites, and phaseout of Pu storage at RFETS.

For all of the storage sites, the No Action Alternative is used as a baseline from which incremental impacts of the storage alternatives are compared. The phaseout associated with these storage alternatives could reduce human health and waste generation impacts and increase the number of lost jobs at some sites.

Site Infrastructure. For the Upgrade Alternatives, all requirements would be within existing site capacities for all sites except for coal at ORR and SRS. Under the Preferred Alternative, coal consumption at ORR and SRS would exceed site storage capacities by less than 1 percent; all other requirements would be within existing site capacities. In those cases where site capacity for fuel storage does not adequately support increased requirements, more frequent deliveries would be scheduled. Increases in resource requirements would be within the following ranges over No Action: electrical energy, 0 to 104 percent (maximum for Pantex); peak electric load, 0 to 90 percent (maximum for Pantex); oil, 0 to 13 percent (maximum for INEL for the Upgrade Alternative); natural gas, 0 to 71 percent (maximum for Pantex); and coal, 0 to 1 percent (maximum for ORR).

For the Consolidation Alteratives, all requirements would be within existing site capacities at all sites except for the following: electrical energy (12 percent over existing capacity), oil (1 percent over existing capacity), and natural gas (no existing capacity) at NTS; coal at INEL (97 percent over existing capacity); and oil (1 percent over existing capacity) and coal (2 percent over existing capacity) at SRS. In these cases where site capacity for fuel storage does not adequately support increased requirements, more frequent deliveries would be scheduled. Increases in resource requirements would be within the following ranges over No Action: electrical energy, 8 to 104 percent (maximum for Pantex); peak electric load, 9 to 90 percent (maximum for Pantex); oil, 1 to 5 percent (maximum for Pantex); natural gas, 0 percent (no existing capacity at NTS); and coal, 0 to 97 percent (maximum for INEL). All infrastructure requirements could be met by increasing procurement or, in the case of NTS, by using a different energy source.

For the Collocation Alternatives, all requirements would be within existing site capacities at all sites except for the following: electrical energy (21 percent over existing capacity), oil (1 percent over existing capacity), and natural gas (no existing capacity) at NTS; coal at INEL (124 percent over existing capacity); oil (3 percent over existing capacity), and coal (35 percent over existing capacity) at ORR; and oil (1 percent over existing capacity) and coal (3 percent over existing capacity) at SRS. In these cases where site capacity for fuel storage does not adequately support increased requirements, more frequent deliveries would be scheduled. Increases in resource requirements would be within the following ranges over No Action: electrical energy, 8 to 126 percent (maximum for Pantex); peak electric load, 9 to 100 percent (maximum for Pantex); oil, 1 to 14 percent (maximum for ORR); natural gas, 0 percent (no existing capacity at NTS); and coal, 0 to 124 percent (maximum for INEL).

Soil, Cultural, and Paleontological. Ground disturbance during construction activities would potentially impact soil; cultural resources (including historic, prehistoric, and Native American); and paleontological resources. The Upgrade Alternatives and the Preferred Alternative would have fewer impacts because they use existing facilities or involve only small areas of ground disturbance. The Consolidation and Collocation Alternatives would have more impacts because they involve more ground disturbance due to the construction of new facilities.

Land Use and Visual Resources. For land use, the larger facilities associated with Consolidation and Collocation Alternatives would use more land (56 to 87 ha [138 to 215 acres]) than the facilities associated with Upgrade and Preferred Alternatives (0 to 0.1 ha [0 to 0.25 acres]). The Collocation Alternative at ORR would change the current VRM Class 4 designation of the Bear Creek Road/Route 95 intersection to Class 5. Visual resources at the other DOE sites would not be affected by the storage alternatives because the facilities would be located near other similar structures.

Air Quality and Noise. Since the Collocation and Consolidation Alternatives would result in more air emission sources (exhaust from delivery trucks, generators, and boilers), slightly greater air quality impacts would occur than with the Upgrade and Preferred Alternatives. The more extensive ground disturbance during construction associated with the Consolidation and Collocation Alternatives would also result in higher levels of PM_{10} and TSP than for the Upgrade and Preferred Alternatives. Potential air emissions for all of the alternatives are within applicable Federal, State, and local air quality standards and guidelines. Minimal noise impacts would be expected from the storage alternatives because of the remote location of the facilities that would be modified or constructed.

Socioeconomics. Beneficial impacts to regional employment would be expected from all storage alternatives at all storage sites (Table S.8–1) except for the site (or sites depending on the alternative) where storage would be phased out. Collocation would generate the largest employment, followed by the Consolidation, Upgrade, and Preferred Alternatives. However, the phaseout at RFETS associated with the Preferred Alternative would result in the loss of approximately 2,200 direct jobs. Due to the small number of the new jobs created by the alternatives relative to the size of the regional economies at all of the DOE sites, community services would not be affected by the long-term storage alternatives. Short-term local transportation impacts may result at all sites from the construction of the facilities associated with the storage alternatives. The larger construction projects (Collocation and Consolidation Alternatives) would have a greater potential to cause short-term congestion on local roads than the smaller construction projects (the Upgrade and Preferred Alternatives).

Table S.8–1. Maximum Incremental Direct Employment Over No Action Generated During Operations at Each Candidate Site

Site	Total Site Employment in 2005	Upgrade	Consolidation	Collocation	Preferred Alternative
Hanford	14,586	252[a]	443	572	0
NTS	3,800	NA	527[b]	641[b]	0
INEL	6,911	116[a]	432	561	0
Pantex	3,559	90[c]	509[d]	601	90[e]
ORR	18,010	111	[f]	566[g]	111
SRS	16,562	30[h]	485	614	30[h,i]

[a] Upgrade with RFETS and LANL materials.
[b] Modify P-Tunnel.
[c] Upgrade with RFETS and LANL materials. Actual number of employees during operation could be higher.
[d] Construct new and modify existing storage facilities.
[e] Upgrade with pits from RFETS.
[f] Since HEU is currently stored at ORR, the Consolidation and Collocation Alternatives would be the same.
[g] Construct new Pu and HEU facilities.
[h] Workers would be supplied from existing site workforce.
[i] Upgrade with non-pit materials from RFETS.
Note: NA=not applicable.

Water Resources. The water resource impacts for the Consolidation and Collocation Alternatives are greater than for the Upgrade and Preferred Alternatives, both in water requirements and wastewater discharges. Wastewater discharge is dependent on the number of employees, which is greatest for the Consolidation and Collocation Alternatives due to the larger facilities. As shown in Table S.8–2, water resource requirements are the greatest for the Collocation Alternative at all DOE sites because collocation includes the maximum amount of Pu and HEU in the PEIS. Water resource requirements for all the alternatives would impact groundwater availability at Pantex because the additional groundwater withdrawal would contribute to the existing overall decline in water levels of the Ogallala Aquifer. However, there should be minimal impacts to regional groundwater levels from this additional withdrawal. At all other sites, water requirements would have minimal impact on water resources because of the abundance of surface water or groundwater.

Table S.8–2. Maximum Annual Net Incremental Water Usage Over No Action During Operation at Each Candidate Site

Site	No Action in 2005 (MLY)	Upgrade (MLY)	Consolidation (MLY)	Collocation (MLY)	Preferred Alternative (MLY)
Hanford	195	8.9[a]	110	150	0
NTS	2,400	NA	130[b]	190[b]	0
INEL	7,570	22[a]	66	87	0
Pantex	249	110[a]	110[c]	130	27.5[d]
ORR	14,760	0.24	[e]	360[f]	0.24
SRS	13,247	7.1[a]	360	460	5.7[g]

[a] Upgrade with RFETS and LANL materials.
[b] Modify P-Tunnel.
[c] Construct new and modify existing storage facility.
[d] Upgrade with pits from RFETS.
[e] Since HEU is currently stored at ORR, the Consolidation and Collocation Alternatives would be the same.
[f] Construct new Pu and HEU facilities.
[g] Upgrade with non-pit materials from RFETS.
Note: MLY=million liters per year; NA=not applicable.

Biological Resources. The Preferred Alternative would have no incremental biological resource impacts at INEL and Hanford, and minimal impacts at Pantex and potentially at SRS because of ground disturbance for upgrades. The Consolidation and Collocation Alternatives would have the potential to impact biological resources at all DOE sites because they would involve ground disturbance. At Pantex, previously disturbed land would be used for consolidation and collocation facilities. Threatened and endangered species at NTS and SRS may be affected by the storage alternatives at these sites.

Environmental Justice. All six DOE storage sites have, within an 80-km (50-mi) radius, census tracts with greater than 25 percent minority or low-income populations. However, the public health and safety analyses show that air emissions and hazardous chemical and radiological releases from normal operations for all storage alternatives would be within regulatory limits and that no latent cancer fatalities would result. The public health and safety analyses also indicate that radiological releases from accidents would not result in disproportionate and adverse human health or environmental impacts. Potential transportation accidents would be random events along transportation corridors. Therefore, none of the storage alternatives would have disproportionately high or adverse impacts on minority or low-income populations.

Waste Management. All of the storage alternatives would impact existing waste management practices at the DOE sites by increasing the amount of waste that must be treated, stored, and disposed. Depending on decisions in the waste-type-specific RODs for the Waste Management PEIS, wastes would be treated and disposed of onsite or at regionalized or centralized DOE sites. Generally, the Consolidation and Collocation Alternatives would generate more wastes than the Upgrade and Preferred Alternatives. Tables S.8–3 through S.8–5 show the maximum incremental waste generation rates for solid TRU, solid low-level, and solid hazardous wastes at the six candidate sites.

Public and Occupational Health and Safety. Table S.8–6 shows the differences between the long-term storage alternatives for radiological exposures to the public. The maximum potential latent cancer fatalities over No

Action for the MEI over 50 years from normal operations ranges from 4.5×10^{-13} for the Upgrade and Preferred Alternatives at Pantex to 1.1×10^{-9} for the Collocation Upgrade Alternative at ORR. This means that the chance of a latent cancer fatality occurring ranges from about 1 in 1 billion to 5 in 10 trillion. The risk varies because of site parameters including the distance from the facility to the MEI (small sites vs. large sites); local meteorological conditions (windspeed, direction, and stability); and the type of material being stored (metals and oxides vs. residues).

Table S.8–3. Maximum Annual Net Incremental Volume of Solid Low-Level Waste Over No Action Generated During Operations at Each Candidate Site

Site	Waste Generated in 2005 (m^3)	Upgrade (m^3)	Consolidation (m^3)	Collocation (m^3)	Preferred Alternative (m^3)
Hanford	3,390	89[a]	1,260	1,300	0
NTS	15,000	NA	1,260	1,300	0
INEL	7,200	500[a]	1,260	1,300	0
Pantex	32	1,260[a]	1,260	1,300	138[b]
ORR	7,320	3	[c]	1,300[d]	3
SRS	16,400	0	1,220[e]	1,260[e]	0

[a] Upgrade with RFETS and LANL materials.
[b] Upgrade with pits from RFETS.
[c] Since HEU is currently stored at ORR, the Consolidation and Collocation Alternatives would be the same.
[d] Construct new Pu and HEU facilities.
[e] Net waste from new facility and from phaseout of existing facility.
Note: NA=not applicable.

Table S.8–4. Maximum Annual Net Incremental Volume of Solid Transuranic Waste Over No Action Generated During Operations at Each Candidate Site

Site	Waste Generated in 2005 (m^3)	Upgrade (m^3)	Consolidation (m^3)	Collocation (m^3)	Preferred Alternative (m^3)
Hanford	271	21[a]	10	10	0
NTS	0	NA	10	10	0
INEL	3.5	2[a]	10	10	0
Pantex	0	10[a]	10	10	0.8[b]
ORR	119	0	[c]	10[d]	0
SRS	338	0	2[e]	2[e]	0

[a] Upgrade with RFETS and LANL materials.
[b] Upgrade with pits from RFETS.
[c] Since HEU is currently stored at ORR, the Consolidation and Collocation Alternatives would be the same.
[d] Construct new Pu and HEU facilities.
[e] Net waste from new facility and from phaseout of existing facility.
Note: NA=not applicable.

Table S.8–5. Maximum Annual Net Incremental Volume of Solid Hazardous Waste Over No Action Generated During Operations at Each Candidate Site

Site	Waste Generated in 2005 (m^3)	Upgrade (m^3)	Consolidation (m^3)	Collocation (m^3)	Preferred Alternative (m^3)
Hanford	560	4	2	2	0
NTS	212	NA	2	2	0
INEL	1,200	1	2	2	0
Pantex	31	2[a]	2	2	1.5[b]
ORR	26	0.8[c]	[d]	2[e]	0.8
SRS	15,100	0.8[a]	2	2	0.6[f]

[a] Upgrade with RFETS and LANL materials.
[b] Upgrade with pits from RFETS.
[c] Total of mixed LLW and hazardous waste because hazardous waste is included in mixed LLW.
[d] Since HEU is currently stored at ORR, the Consolidation and Collocation Alternatives would be the same.
[e] Construct new Pu and HEU facilities.
[f] Upgrade with non-pit materials from RFETS.
Note: NA=not applicable.

Table S.8–6. Maximum Latent Cancer Fatalities Over No Action for Maximally Exposed Individual for 50 Years From Normal Operations at Each Candidate Site

Site	No Action in 2005	Upgrade	Consolidation	Collocation	Preferred Alternative
Hanford	1.0×10^{-8}	4.5×10^{-11}	6.2×10^{-11}	6.2×10^{-11}	0
NTS	1.0×10^{-7}	NA	1.4×10^{-10}	1.4×10^{-10}	0
INEL	4.4×10^{-7}	1.3×10^{-11}	4.0×10^{-11}	4.0×10^{-11}	0
Pantex	1.5×10^{-9}	4.5×10^{-13}	2.4×10^{-10}	2.4×10^{-10}	4.5×10^{-13}
ORR	3.5×10^{-8}	5.5×10^{-13}	[a]	1.1×10^{-9}	5.5×10^{-13}
SRS	2.0×10^{-5}	2.1×10^{-10}	3.5×10^{-10}	3.5×10^{-10}	2.1×10^{-10}

[a] Since HEU is currently stored at ORR, the Consolidation and Collocation Alternatives would be the same.
Note: NA=not applicable.

Potential accidents were postulated for each of the long-term storage alternatives. The risk of cancer fatalities to the population located within 80 km (50 mi) of the accident release point for the accident scenario evaluated with the highest risk (PCV penetration by corrosion) for the Upgrade Alternative would be: 4.3×10^{-4} at Hanford; 1.6×10^{-3} at INEL; 8.8×10^{-4} at Pantex (Preferred Alternative); 3.0×10^{-5} at ORR (Preferred Alternative); and 4.6×10^{-4} at SRS. For both the Consolidation and Collocation Alternatives, the highest risk to the population located within 80 km (50 mi) of the accident release point associated with the accident scenarios evaluated (PCV penetration by corrosion) would be: 4.2×10^{-3} at Hanford; $5.1 \times 10^{-5}/9.4 \times 10^{-5}$ at NTS (P-Tunnel/New Pu and HEU Facility); 1.2×10^{-3} at INEL; 1.4×10^{-3} at Pantex; and 1.7×10^{-2} at ORR; and 4.6×10^{-3} at SRS. Since Pu accidents dominate the accident spectrum, the risks would be higher for the Consolidation and Collocation Alternatives because these alternatives would require more Pu at a single DOE site than the Upgrade Alternative.

Intersite Transportation. For intersite transportation, the Upgrade and Preferred Alternatives would have lower potential for fatalities. For the Preferred Alternative, the number of potential fatalities ranges from 0 at Hanford and INEL (since there is no transport of material) to 0.06 at SRS. The Consolidation and Collocation Alternatives would have the higher potential for intersite transportation fatalities because they would move the greatest amount of material between sites. The number of potential fatalities ranges from 0.079 (Consolidated Storage Alternative at Pantex) to 1.07 (Collocated Storage Alternative at Hanford). Intersite transportation impacts would primarily result from nonradiological sources, such as fatalities from nonradiological traffic accidents.

DISPOSITION ALTERNATIVES

Table S.8–7 depicts total campaign data for the disposition alternatives including the Preferred Alternative for disposition. A total of approximately 50 t (55.1 tons) of surplus Pu is assumed to be processed over the life of the campaign. In preparation for disposition under any alternative, surplus Pu must be processed through either the pit disassembly/conversion facility or the Pu conversion facility. Approximately 32.5 t (35.8 tons) are assumed to be processed at the pit disassembly/conversion facility, and approximately 17.5 t (19.3 tons) at the Pu conversion facility. Since these two facilities produce the input material for the other disposition facilities, actions at these two facilities would be the first to occur for the campaign. The operating period for these two facilities for each disposition alternative, including the Preferred Alternative, is 10 years.

Table S.8–7. Total Campaign Data (Approximate) for Disposition Alternatives and the Preferred Alternative

	Disposition Alternatives			Preferred Alternative		
Action	Total Pu (t)	Throughput (t/yr)	Years In Operation	Total Pu (t)	Throughput (t/yr)	Years In Operation
Pit disassembly/ conversion	32.5	3.25	10	32.5	3.25	10
Pu conversion	17.5	1.75	10	17.5	1.75	10
Direct to borehole	50	5	10	NA	NA	NA
Immobilized to borehole	50	5	10	NA	NA	NA
Vitrification	50	5	10	17.5[a]	5[a]	3.5[a]
Ceramic immobilization	50	5	10	17.5[a]	5[a]	3.5[a]
Electrometallurgical treatment	50	5	10	NA	NA	NA
MOX fuel fabrication	50	3	17	32.5	3	11
5 Existing LWRs[b]	50	3	17	32.5	3	11
2 Partially completed LWRs[c]	50	3	17	NA	NA	NA
2 Large or 4 small evolutionary LWRs	50	3	17	NA	NA	NA
CANDU reactors[d]	50	3.8	13	NA	NA	NA

[a] Either vitrification or ceramic immobilization would be implemented for immobilization of surplus Pu under the Preferred Alternative, but not both.
[b] Three to five existing LWRs would be used depending upon the amount of MOX fuel in the reactor core.
[c] If the partially completed LWRs were to be completed by other parties, they would be considered existing LWRs and could compete for the surplus Pu disposition mission under the Preferred Alternative.
[d] The CANDU reactor is retained in the event a multilateral agreement is made among Russia, Canada, and the United States to use CANDU reactors.
Note: NA=not applicable.

The operation of the disposition facilities for a single disposition alternative would require between 10 and 17 years to accomplish the disposition mission. However, the Preferred Alternative may result in fewer years of operation for the disposition facilities, since the 50 t (55.1 tons) of surplus Pu would be dispositioned under two different technologies. For purposes of analysis, it is assumed that approximately 17.5 t (19.3 tons) of surplus Pu would be immobilized through vitrification or ceramic immobilization, and approximately 32.5 t (35.8 tons) would be converted to MOX fuel for use in reactors,[20] under the Preferred Alternative. The number of years in

[20] The actual amount dispositioned under each disposition technology would depend on subsequent NEPA analysis, costs, test and demonstration results, international agreements, and the procurement process among other things.

operation for each disposition technology may be less than that required to process the full 50 t (55.1 tons) with any single disposition alternative.

Actual years of operation and Pu throughput rates for any of the reactor disposition alternatives would not exceed 17 years and 3.8 t/yr (4.2 tons/yr), respectively, but could be less depending upon the final reactor core design. Variables such as the amount of MOX fuel included in each core have not yet been determined and would affect the years required to complete the mission using the reactor alternatives. Conservative estimates for throughput and years in operation are presented for comparing the Reactor Alternatives with the Preferred Alternative.

Table S.8–8 presents a comparison of the total campaign impacts from the disposition of 50 t (55.1 tons) of surplus Pu for key environmental resources for the individual disposition alternatives and the Preferred Alternative. Since the ceramic immobilization facility generally has greater impacts than the vitrification facility, it was used in the calculation of the total campaign impacts for the Preferred Alternative. A comparison of impacts is not included for community services, environmental justice, and noise since the impacts are highly site-specific.

Biological, Geology and Soil, Land Use, and Cultural and Paleontological Resources. Ground disturbance during construction activities would potentially impact soil; biological; cultural resources (including historic, prehistoric, and Native American); and paleontological resources for all of the disposition alternatives. The immobilization alternatives would disturb the least amount of land while the Evolutionary LWR Alternative would disturb the most land area because it would require the most new construction. However, when considering operational land area, the two Deep Borehole Alternatives would require the most land because of the 1.6-km (1-mi) radius buffer zone. Depending upon location, all of the alternatives could result in visual resource impacts by changing the visual resource management classification of an area. The Deep Borehole Alternatives would impact geologic resources because the borehole operations would render the site perpetually unusable.

Site Infrastructure and Water Resources. The evolutionary LWR would require the largest electrical load during operations. The Evolutionary LWR and the Partially Completed LWR Alternatives would require the most additional water for operations. The rest of the alternatives would require nearly the same amount of water, with the exception of the Electrometallurgical Treatment Alternative, which would require the least amount of water.

Air Quality and Socioeconomics. Potential construction-related impacts on air quality and local transportation would be minor for all of the disposition alternatives and the Preferred Alternative. The Evolutionary LWR and Partially Completed LWR Alternatives would generate the most employment and income among the alternatives. For local transportation, the Evolutionary LWR Alternative would have the greatest potential of reducing the level of service on local roads during construction and/or operations. Some reduction in level of service would also be expected for the Vitrification, Ceramic Immobilization, and the Preferred Alternatives.

Public and Occupational Health and Safety. There would be potential for impacts to public and occupational health and safety from the radiological and hazardous chemical doses during operations of all the disposition alternatives, including the Preferred Alternative; however, the annual radiological doses to onsite workers and the public would be within regulatory limits for all alternatives. For hazardous chemicals, potential impacts to the public and onsite workers would not be expected to cause adverse health affects.

A set of potential accidents was postulated for each of the disposition technology alternatives. The risk of cancer fatalities to the population located within 80 km (50 mi) of the accident release point for the front-end disposition process campaign would range from 4.5×10^{-16} to 1.7×10^{-4} for pit disassembly/conversion (for the highest accident risk scenario [fire on loading dock] at the potential disposition sites: 4.6×10^{-5} at Hanford; 1.4×10^{-5} at INEL; 1.6×10^{-5} at Pantex; and 5.0×10^{-5} at SRS) and from 1.5×10^{-16} to 1.3×10^{-4} for Pu conversion

Table S.8–8. Comparison of Resource Use and Impacts From the Total Campaign for the Operation of Disposition Alternatives[a]

Alternatives	Total Number of Worker-Years	Water Usage (million l)	Latent Cancer Fatalities for MEI from Lifetime Accident-Free Operation	Solid TRU Waste Generated (m^3)	Solid Low-Level Waste Generated (m^3)	Solid Hazardous Waste Generated (m^3)
Direct to borehole	20,550	3,405	$1.2x10^{-9}$ to $1.2x10^{-7}$	3,452	18,500	287
Immobilized to borehole	29,550	6,605	$1.2x10^{-9}$ to $1.2x10^{-7}$	4,955	18,740	497
Vitrification	24,810	4,251	$1.2x10^{-9}$ to $1.2x10^{-7}$	4,440	18,590	307
Ceramic immobilization	25,730	4,251	$1.2x10^{-9}$ to $1.2x10^{-7}$	4,440	18,590	307
Electrometallurgical treatment	17,960	1,751	$1.2x10^{-9}$ to $1.3x10^{-7}$	3,510	19,000	125
5 Existing LWRs[b]	29,030	2,717	$1.3x10^{-6}$ to $2.6x10^{-6}$	8,652	21,051	2,718
2 Partially completed LWRs[c]	47,305	2,352,000	$9.8x10^{-6}$ to $9.9x10^{-6}$	8,652	22,955 to 42,709	3,636
2 Evolutionary large LWRs[d]	53,850	2,062,000	$5.8x10^{-7}$ to $8.2x10^{-5}$	8,652	38,051	3,636
4 Evolutionary small LWRs[e]	59,630	1,856,000	$8.4x10^{-7}$ to $9.6x10^{-5}$	8,652	39,411	4,554
CANDU reactors[f]	25,630	2,717	$1.8x10^{-9}$ to $1.2x10^{-7}$	8,652	21,051	2,718
Preferred Alternative[g]	16,140	3,253	$9.0x10^{-7}$ to $1.7x10^{-6}$	7,163	20,182	1,866

[a] Data includes all front-end processes (Pu conversion, pit disassembly/conversion, and MOX fuel fabrication) that would be needed for the individual alternatives. The total campaign impacts were calculated by multiplying the annual impacts times the number of years of operation, as identified in Table S.8–7.
[b] The table reflects the use of 5 existing LWRs. Three to five existing LWRs would be used depending upon the amount of MOX fuel in the reactor core.
[c] The table reflects the use of 2 partially completed LWRs.
[d] The table reflects the use of 2 evolutionary large LWRs.
[e] The table reflects the use of 4 evolutionary small LWRs.
[f] The table reflects impacts from pit disassembly/conversion and MOX fuel fabrication in the United States.
[g] Ceramic immobilization and 5 existing LWRs are the assumed technologies for the Preferred Alternative for comparative purposes only.

(for the highest accident risk scenario [fire on loading dock] at the potential disposition sites: $3.5x10^{-5}$ at Hanford and $3.2x10^{-5}$ at SRS). Within the borehole category, the risk of cancer fatalities to the population located within 80 km (50 mi) of the accident release point for direct disposition campaign would range from $8.4x10^{-16}$ to $6.3x10^{-8}$. For both the ceramic immobilization front-end process prior to immobilized disposal, and ultimate disposition in the deep borehole complex, the risks would range from $9.3x10^{-18}$ to $6.3x10^{-8}$ and $9.3x10^{-19}$ to $6.3x10^{-9}$, respectively for the disposition campaign. The risk of cancer fatalities to the population located within 80 km (50 mi) of the accident release point for the immobilization category would range from $2.8x10^{-14}$ to $1.8x10^{-5}$ for the vitrification alternative and from $7.0x10^{-16}$ to $1.9x10^{-7}$ for the ceramic immobilization alternative over the disposition campaign (for the highest accident scenario [criticality] at the potential disposition sites and 30 percent immobilization campaign: 1.7×10^{-8} at Hanford and 2.1×10^{-8} at SRS). For the immobilization of Pu through electrometallurgical treatment of spent fuels, the projected campaign risk to the population would be 3.5×10^{-7} for the accident scenario evaluated with the highest risk (a breach in the argon cell initiated by a design basis earthquake).

For the reactor alternative, the risk of cancer fatalities to the population located within 80 km (50 mi) of the accident release point for the MOX fuel fabrication facility would range from 4.6×10^{-16} to 4.3×10^{-4} for the campaign (for the highest accident scenario [fire on loading dock] at the potential disposition sites using for analysis purposes, approximately 70 percent disposition campaign: 5.2×10^{-5} at Hanford; 1.6×10^{-5} at INEL; 1.8×10^{-5} at Pantex; and 5.2×10^{-5} at SRS). The risk of cancer fatalities to the population located within 80 km (50 mi) of the accident release point for the MOX-fueled evolutionary LWR would range from 9.6×10^{-11} to 6.9×10^{-6}. Under the Preferred Alternative, DOE would pursue the use of MOX-fueled LWRs. The incremental effects of utilizing MOX fuel in a reactor in place of UO_2 were derived from a quantitative analysis of severe accident release scenarios for MOX and UO_2 using the MACCS computer code and generic population and meteorology data. The analysis only considers severe accidents where sufficient damage would occur to cause the release of Pu or uranium. The risks of severe accidents were found to be in the range of plus 8 to minus 7 percent, compared to UO_2 fuel, depending on the accident release scenario. The incremental risk of cancer fatalities to a generic population located within 80 km (50 mi) of the severe accident release point would range from -2.0×10^{-4} to 3.0×10^{-5} per year.

Waste Management. The reactor alternatives and the Preferred Alternative would be the only alternatives that would generate spent nuclear fuel. The Partially Completed LWR Alternative would generate the largest incremental increase in spent nuclear fuel. The Preferred Alternative would generate the lowest incremental increase of spent nuclear fuel among the reactor alternatives because the combination of disposition technologies would require less Pu to go through reactors. The reactor alternatives and the Preferred Alternative would also generate the most solid TRU, solid low-level, and solid hazardous waste among the alternatives.

Intersite Transportation. The Evolutionary LWR and Partially Completed LWR Alternatives would have the highest potential fatalities over the total campaign because they would require the most material transport. The Preferred Alternative and Electrometallurgical Treatment Alternative would have the lowest potential fatalities from transportation. Intersite transportation impacts would primarily be the result of nonradiological impacts such as fatalities from nonradiological highway accidents.

S.9 SUMMARY OF MAJOR ISSUES IDENTIFIED DURING THE COMMENT PERIOD AND CHANGES TO THE DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

S.9.1 ISSUES IDENTIFIED AND RESOLVED

The Department initially issued the Storage and Disposition PEIS as a draft for public comment for the period from March 8 through May 7, 1996. In response to public requests, DOE extended the comment period deadline to June 7, 1996. Public meetings on the Draft PEIS were held in March and April 1996 at the following locations:

Denver, CO	March 26, 1996
Las Vegas, NV	March 28–29, 1996
Oak Ridge, TN	April 2, 1996
Richland, WA	April 11, 1996

Idaho Falls, ID	April 15, 1996
Washington, DC	April 17–18, 1996
Amarillo, TX	April 22–23, 1996
North Augusta, SC	April 30, 1996

During the 92-day public comment period on the Storage and Disposition Draft PEIS, DOE received comments on the document by mail, fax, telephone recording, electronic mail, and orally at the public meetings. Altogether, DOE received approximately 8,700 written and recorded comments from individuals and organizations. All comments are presented in Volume IV of the Storage and Disposition Final PEIS, the *Comment Response Document.*

Approximately 80 percent of the comments received consisted of mail-in letter and postcard campaigns which expressed either support of or opposition to the use of various sites or alternatives. Many commentors encouraged DOE and the United States to become the world leader in the safe, secure, and timely disposition of Pu, and favored worldwide nonproliferation efforts for surplus Pu. The following highlights recurring comments, DOE's response, and the PEIS revisions in response to these comments.

A number of commentors expressed the opinion that the surplus Pu should remain in present locations for future energy or weapons use, or until new technologies are available for disposition. In response to these concerns, DOE expanded the discussion on the need for the proposed Pu disposition action in the PEIS. Disposition is necessary to implement the President's *Nonproliferation and Export Control Policy* in a safe, reliable, cost-effective, and timely manner.

Some commentors also stated that DOE should consider additional disposition alternatives, including the use of FFTF, deep burn reactors, and mononitride reactors. The use of advanced reactors such as deep burn reactors and mononitride reactors was considered but eliminated due to the technical immaturity, attendant costs, and lengthy development and demonstration efforts required to bring the technologies to a viable, practical status and enable disposition options to be initiated with certainty. The FFTF would be considered for Pu disposition if first selected for tritium production. The FFTF is not a reasonable, stand-alone alternative because it is in a standby status awaiting shutdown and because it could not satisfy the criterion of completing the disposition mission within 25 years. A discussion of FFTF for this purpose is included in Appendix N. In all, thirty-seven different alternative options were considered by DOE for disposition of Pu. DOE has made revisions to the Summary and Chapter 2 of the PEIS to clarify how the screening process was used for selection of reasonable alternatives.

Commentors noted that transportation of fissile materials is one of their major concerns with the Program. The ground transportation between sites, in the event a consolidation alternative was selected, could increase the potential for traffic accidents. International transportation for specific border crossings for the shipment of MOX fuel to Canada for the CANDU Reactor Alternative was also identified as a concern. DOE acknowledges the public's concern, and in response, the transportation analysis in Section 4.4 and Appendix G of the Draft PEIS was expanded. The revisions address security measures for land and sea transport, emergency preparedness, and clarify the results of analyses performed.

One frequently recurring comment presented by the public relates to the technical, cost, schedule, and nonproliferation analyses to support DOE's ROD. Many of the commentors suggested that DOE should make information available for public review. Since issuance of the Draft PEIS, DOE has prepared both the *Technical Summary Report for Long-Term Storage of Weapons-Usable Fissile Materials* (DOE/MD-0004 Rev. 1) and the *Technical Summary Report for Surplus Weapons-Usable Plutonium Disposition* (DOE/MD-0003 Rev. 1). These two reports summarize representative technical, cost, and schedule data for the reasonable alternatives being considered for long-term storage and surplus Pu disposition, respectively. In July and August 1996, these documents were initially distributed for public review and comment. After taking the public's comments into consideration, DOE revised and re-issued both reports in November and December 1996. In October 1996, DOE issued the *Draft Nonproliferation and Arms Control Assessment of Weapons-Usable Fissile Material Storage and Plutonium Disposition Alternatives*, which analyzes the nonproliferation and arms reduction implications of the alternatives addressed in the PEIS for Pu and HEU storage and the disposition of surplus Pu. From October through early November 1996, the public was asked to review and comment on the draft nonproliferation document; this process included a series of 10 public meetings held nationwide. Public comments received are being taken into consideration in revising the report, which is scheduled for re-issue in late 1996. This report, in conjunction with the Final PEIS, the technical summary reports previously described, and public input, will form the basis for DOE's decisions, which will be discussed in a ROD to be issued no sooner than 30 days after publication of the Environmental Protection Agency's Notice of Availability of the Final PEIS.

Commentors also stated that the U.S. Nonproliferation Policy does not encourage the civil use of Pu or Pu processing for either nuclear power or nuclear explosive purposes. The commentors requested that the PEIS address the possibility that the MOX option would have an adverse effect on U.S. nonproliferation policy by encouraging its use in civil nuclear power programs and by encouraging Pu reprocessing and recycling. DOE acknowledges the public concern for nonproliferation. As discussed in the PEIS, the reactor option would utilize a once-through fuel cycle. Spent fuel from disposition would be disposed of with other commercial reactor spent fuel. This is consistent with U.S. policy since no Pu in the spent fuel would be recycled. Revisions to the Summary and Chapter 1 of the PEIS were made to expand and clarify this issue.

Commentors indicated that the isotopic composition of the residual Pu in the final waste forms is an inappropriate criterion by which to assess proliferation risks because it perpetuates a myth that reactor-grade Pu cannot be used to make workable weapons. In the opinion of these commentors, isotopic degradation does not constitute a compelling argument in favor of the MOX option. DOE acknowledges that, although it may be possible to make a nuclear weapon from spent commercial reactor fuel, this can only be done with extreme difficulty by individuals with a great deal of experience in handling and processing nuclear materials. DOE believes that the disposition of weapons Pu through the use of MOX fuel in reactors would meet the Spent Fuel Standard in creating a radiological barrier that makes the Pu as difficult to retrieve and reuse in weapons as Pu in spent commercial fuel. The use of this technology would allow for the Pu to be disposed in a geologic repository, the same as for spent commercial fuel. Revisions to Chapter 1 of the PEIS were made to clarify this issue.

S.9.2 CHANGES MADE TO THE DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

This section identifies changes made since the issuance of the Draft PEIS. The Final PEIS includes the Preferred Alternative, which is a combination of other alternatives and is described in Section S.2 and Section 1.6. Other changes, after considering public comments, are described below.

Appendix N, which in the Draft PEIS summarized the operational aspects of the multipurpose reactor, has been revised for the Final PEIS to provide information on the costs and benefits of conducting separate tritium production and Pu disposition missions versus the costs and benefits of carrying out one multipurpose mission. Included in Appendix N is a cost comparison of using new Advanced LWRs or Modular Helium Reactors, and a discussion of issues regarding the use of the FFTF (a liquid metal reactor at Hanford) for tritium production and Pu disposition.

Appendices O, P, Q, and R were added to the Final PEIS to help clarify alternative issues as they relate to the Preferred Alternative. Appendix O describes two can-in-canister technology concepts at SRS, which are variants of the Vitrification and Ceramic Immobilization Disposition Alternatives described in Chapter 2. This information was added based on public interest in these concepts during the Draft PEIS comment period, and also because of DOE's reconsideration of this technology as being a viable approach for Pu disposition through immobilization.

Appendix P provides a description of using the Manzano Weapons Storage Area (WSA) near Albuquerque, NM to store Pu pits. This appendix was added because DOE's Preferred Alternative separates the storage of pits from non-pit materials, in which case Manzano WSA no longer appears unreasonable under the Preferred Alternative for pit storage. However, since DOE's preferred site for interim storage of pits is Pantex (as described in the Pantex EIS) and since the majority of pits are already located in storage at Pantex, the Preferred Alternative proposes the long-term storage of Pu pits at Pantex. Weapons assembly/disassembly would continue at Pantex in any case. Construction of a new storage facility at Manzano would create needless expense and transportation risk.

Appendix Q describes the operations and human (radiological) health impacts associated with Pu pits being transferred from RFETS to Pantex, repackaged in Zone 12 South, and placed in storage in Zone 4 West at Pantex, as part of the Preferred Alternative for long-term storage. The information presented in this appendix is based on the Pantex EIS analysis of storing the Pu pits already at Pantex.

Appendix R discusses aircraft crash and radioactive release probabilities for proposed storage and disposition facilities at Pantex.

Section 1.2 of the Final PEIS has been revised to reflect the cooperative effort between the United States and Russia to study different options for managing excess Pu (including secure storage, conversion of Pu weapons components to other forms, and stabilization of unstable forms of Pu), and options for disposition of excess Pu (deep borehole, immobilization, and reactors). The results of this study have been documented in the *Joint United States/Russian Plutonium Disposition Study* report, completed in September 1996. This study and the options considered will provide decisionmakers from both countries with a set of jointly evaluated alternatives for Pu disposition and help build further trust and cooperation in the area of fissile material disposition.

Office of
Fissile Materials Disposition

United States Department of Energy

Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement

Volume I

December 1996

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Final Programmatic Environmental Impact Statement/Volume I

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ABSTRACT: This document analyzes the potential environmental consequences of alternatives for the long-term storage (up to 50 years), including storage until disposition, and disposition of weapons-usable fissile materials from U.S. nuclear weapon dismantlements under the responsibility of the DOE. Long-term storage of nonsurplus inventories of weapons-usable plutonium (Pu) and highly enriched uranium (HEU) are required for national defense purposes, while the disposition of surplus weapons-usable Pu is necessary in order to implement our national nonproliferation policy. In addition to the No Action Alternative, this PEIS assesses three storage alternatives (that is, upgrade at multiple sites, consolidation of Pu, and collocation of Pu and HEU) at six DOE candidate sites located across the country. These sites are Hanford Site, Nevada Test Site, Idaho National Engineering Laboratory, Pantex Plant, Oak Ridge Reservation, and Savannah River Site. Although they are not candidate sites for storage, Rocky Flats Environmental Technology Site (RFETS) and Los Alamos National Laboratory are assessed for the No Action Alternative. For the disposition of surplus Pu, three alternative categories (that is, deep borehole, immobilization, and reactor) with nine primary alternatives are assessed at several DOE and representative sites for analysis purposes. Evaluations of impacts on site infrastructure, water resources, air quality and noise, socioeconomics, waste management, public and occupational health and safety, and environmental justice are included in the assessment. The intersite transportation of nuclear and hazardous materials is also assessed. DOE's Preferred Alternative is identified in this Final PEIS. The Preferred Alternative for storage is a combination of No Action and Upgrade Alternatives for the various DOE sites, and phaseout of Pu storage at RFETS. The Preferred Alternative for disposition of surplus Pu is to pursue a disposition strategy involving a combination of immobilization and reactor alternatives, including vitrification, ceramic immobilization, and existing reactors.

PUBLIC INVOLVEMENT: The DOE issued a Draft PEIS on March 8, 1996, and held a formal public comment period on the Draft through June 7, 1996. In preparing the Final PEIS, DOE considered comments received via mail, fax, electronic bulletin board (Internet), and transcripts of messages recorded by telephone. In addition, comments and concerns were recorded by notetakers during interactive public meetings held during March and April 1996 in Denver, CO, Las Vegas, NV, Oak Ridge, TN, Richland, WA, Idaho Falls, ID, Washington, DC, Amarillo, TX, and North Augusta, SC. Comments received and DOE's responses to those comments are found in Volume IV of the Final PEIS.

FOREWORD

This is the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (PEIS), prepared by the U.S. Department of Energy, Office of Fissile Materials Disposition. The document is composed of four volumes and a separate Summary. Changes made since the Draft PEIS are shown by change bar notation (vertical lines adjacent to the changes) in this Final PEIS for both text and tables. Deletion of one or more sentences is indicated by the phrase "Text deleted." in brackets. This Final PEIS includes the Preferred Alternative, which is a combination of alternatives. The Preferred Alternative is described in Section 1.6 and Chapter 2 of Volume I, and analyzed in Chapter 4 of Volume II. For all the alternatives, including the Preferred Alternative, a comparison of alternatives is presented in Section 2.5 of Volume I and a summary of impacts is presented in Section 4.6 of Volume II (Part B). Information from these sections is also presented in the Summary.

Volume I contains Chapters 1 through 3 of the PEIS. Chapter 1 includes a description of the history and background of the fissile materials disposition program, the purpose of and need for the proposed action, a summary of changes made to the Draft PEIS, and the Preferred Alternative. Chapter 2 gives a description of the proposed long-term storage and disposition alternatives, a description of how the alternatives were selected and why others were eliminated from further consideration, and a comparison of the alternatives in terms of their potential environmental impacts. Chapter 3 describes the affected environment at candidate long-term storage locations, and at sites and environmental settings for the disposition alternatives.

Volume II (Parts A and B) contains Chapters 4 through 10 of the PEIS. Chapter 4 describes the potential environmental impacts resulting from construction and operation of the proposed long-term storage and disposition alternatives, including the Preferred Alternative. Also contained in this chapter are intersite transportation impacts, a discussion of environmental justice issues, cumulative impacts due to the implementation of the proposed alternatives in addition to other actions at a site, avoided environmental impacts, and a summary of impacts. Chapter 5 provides a list of references used in the preparation of this document. Chapter 6 provides an index to the main text of the PEIS. Chapter 7 is a glossary of key terms used in the document. Chapter 8 is a list of preparers. Chapter 9 lists government agencies and organizations contacted during the preparation of this PEIS. Chapter 10 provides a distribution list for the document.

Volume III contains the appendices to this PEIS. Appendix A contains the fact sheet on the President's *Nonproliferation and Export Control Policy*, and the Joint Statement Between the United States and Russia on Nonproliferation. Appendix B provides specifications for key buildings within each facility complex analyzed in this PEIS. Appendix C describes requirements for construction and operation of the various facilities required to accomplish the storage and disposition activities essential to the alternatives described in this PEIS. Appendix D provides information on overall water usage for the storage and disposition facilities discussed in this PEIS. Appendix E gives a general overview of the Department of Energy (DOE) environmental restoration and waste management program, baseline waste management at DOE sites, and project-specific waste management activities associated with the proposed long-term storage and disposition alternatives. Appendix F provides detailed data supporting the air quality and noise analyses. Appendix G describes the methodology used for intersite transportation risk analysis and provides a summary of hazardous materials shipped to and from DOE sites, plus information on shipping containers. Appendix H evaluates various plutonium waste forms for potential disposal in a high-level waste repository. Appendix I describes operations of a Canadian Deuterium Uranium Reactor. Appendix J identifies the compliance requirements associated with the Proposed Action, as specified by the major Federal and State environmental, safety, and health statutes, regulations, and orders. Appendix K lists the scientific names of common nonthreatened and nonendangered animal and plant species identified in Chapters 3 and 4. Appendix L includes the supporting data used for assessing the No Action

Alternative in the socioeconomics sections of this PEIS. Appendix M presents detailed information on the potential health risks associated with releases of radioactivity and hazardous chemicals from the proposed storage and disposition alternatives during normal operations and from postulated accidents. Appendix N describes different concepts for, and provides cost and benefit information on, the multipurpose reactor. Appendix O provides a description of facilities and operations for a can-in-canister approach to plutonium immobilization at the Savannah River Site in South Carolina. Appendix P describes the potential environmental impacts of using the Manzano Weapons Storage Area in New Mexico for the long-term storage of plutonium pits. Appendix Q identifies the potential health impacts from the storage of Rocky Flats Environmental Technology Site plutonium pits at the Pantex Plant in Texas. Appendix R discusses the aircraft crash and radioactive release probabilities for proposed storage and disposition facilities at Pantex Plant in Texas. A separate Classified Appendix was also prepared, which provides detailed analysis results for intersite transportation risks based on classified inventories of materials stored at DOE sites.

Volume IV (Parts A and B) is the Comment Response Document. It contains an overview of the public comment process, the comments received on the Draft PEIS during the public review period, and the DOE responses to those comments, including identifying changes made to the Draft PEIS in response to public comments.

The Summary provides a brief overview of the PEIS. It includes the purpose of and need for the Proposed Action, a description of the storage and disposition alternatives including the Preferred Alternative, and the potential environmental impacts resulting from these alternatives.

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LIST OF ACRONYMS AND ABBREVIATIONS

AADT	Average Annual Daily Traffic
ACEC	Area of Critical Environmental Concern
ACGIH	American Conference of Governmental Industrial Hygienists
AEA	*Atomic Energy Act*
AEC	Atomic Energy Commission
AGV	automated guided vehicle
ALARA	as low as reasonably achievable
ALE	Arid Lands Ecology Reserve
ANL-W	Argonne National Laboratory-West
APSF	Actinide Packaging and Storage Facility
AQCR	Air Quality Control Region
ARA	Auxiliary Reactor Area
ARIES	Advanced Recovery and Integrated Extraction System
BEA	Bureau of Economic Analysis
BEIR	biological effects of ionizing radiation
BLM	Bureau of Land Management
BOP	balance-of-plant
BPA	Bonneville Power Administration
BWR	boiling water reactor
CAA	*Clean Air Act*
CANDU	Canadian deuterium uranium
CAS	Chemical Abstracts Service
CCDF	complimentary cumulative distribution function
CEQ	Council on Environmental Quality
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
CFA	Central Facilities Area
CFR	Code of Federal Regulations
CGTO	Consolidated Group of Tribes and Organizations
CI	confidence interval
CIC	can-in-canister
CLUP	Comprehensive Land-Use Plan
CMR	Chemistry and Metallurgy Research

COE	Corps of Engineers
Complex	Nuclear Weapons Complex
CRD	Comment Response Document
CRT	Cargo Restraint Transporters
CWA	*Clean Water Act*
D&D	decontamination and decommissioning
DAF	Device Assembly Facility
DCG	derived concentration guide
DHLW	defense high-level waste
DNB	departure of nucleate boiling
DNFSB	Defense Nuclear Facilities Safety Board
DNL	day and night average sound levels
DNWR	Desert National Wildlife Range
DoD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
DP	Office of Defense Programs
DRCOG	Denver Regional Council of Governments
DWPF	Defense Waste Processing Facility
EA	environmental assessment
EBR	Experimental Breeder Reactor
EDNA	Environmental Design for Noise Abatement
EIA	Energy Information Administration
EIS	environmental impact statement
EM	Office of Environmental Management
EPA	Environmental Protection Agency
ERR	excess relative risk
ES&H	Office of Environment, Safety, and Health
ESA	*Endangered Species Act*
ETF	effluent treatment facility
FAIR	Forest, Agriculture, Industry, and Research
FCF	Fuel Cycle Facility
FEMA	Federal Emergency Management Agency
FFCA	Federal Facility Compliance Agreement
FFTF	Fast Flux Test Facility

FLPMA	*Federal Land Planning Management Act*
FMEF	Fuels and Materials Examination Facility
FMF	Fuel Manufacturing Facility
FONSI	Finding of No Significant Impact
FR	Federal Register
FSAR	Final Safety Analysis Report
GBZ	Glass-bonded zeolite
GESMO	Generic Environmental Statement on Mixed Oxide
GIS	Geographical Information System
GMA	*Growth Management Act*
GMODS	Glass Material Oxidation Dissolution System
HAD	hazard analysis document
Hanford	Hanford Site
HE	high explosives
HEAST	Health Effects Summary Table
HEPA	high-efficiency particulate air
HEU	highly enriched uranium
HEU EIS	*Disposition of Surplus Highly Enriched Uranium Environmental Impact Statement*
HFEF	Hot Fuel Examination Facility
HI	Hazard Index
HLW	high-level waste
HQ	Hazard Quotient
HRA EIS	*Hanford Remedial Action Environmental Impact Statement and Comprehensive Land Use Plan*
HVAC	Heating Ventilation and Air Conditioning
HWR	Heavy Water Reactor
IAEA	International Atomic Energy Agency
ICPP	Idaho Chemical Processing Plant
ICRP	International Commission of Radiological Protection
INEL	Idaho National Engineering Laboratory
IRIS	Integrated Risk Information System
ISCST2	Industrial Source Complex Short-Term Model Version 2
ISO	International Standards Organization
IWG	Interagency Working Group
K-25	K-25 Site

L/ER	Energy Research Program Office
LA	Limited Area
LAA	Limited Access Area
LANL	Los Alamos National Laboratory
LANSCE	Los Alamos Neutron Scattering Center
LCF	latent cancer fatalities
LDR	Land Disposal Restriction
LEU	low-enriched uranium
LIGO	Laser Interferometer Gravitational-Wave Observatory
LLNL	Lawrence Livermore National Laboratory
LLW	low-level waste
LOB	Laboratory Office Building
LWR	Light Water Reactor
MAA	Material Access Area
MACCS	Melcor Accident Consequence Code System
MC&A	Material Control and Accountability
MD	Office of Fissile Materials Disposition
MEI	maximally exposed individual
MHR	Modular Helium Reactor
MMI	Modified Mercalli Intensity
MOX	mixed oxide
MSL	mean sea level
NAAQS	National Ambient Air Quality Standards
NAGPRA	*Native American Graves Protection and Repatriation Act*
NAS	National Academy of Sciences
NCDC	National Climatic Data Center
NCRP	National Commission of Radiological Protection
NEIC	National Earthquake Information Center
NEPA	*National Environmental Policy Act*
NERP	National Environmental Research Park
NESHAP	National Emission Standards for Hazardous Air Pollutants
NFS	Nuclear Fuel Services Fuel Fabrication Plant
NHPA	*National Historic Preservation Act*
NIOSH	National Institute of Occupational Safety and Health
NMSF	Nuclear Material Storage Facility

NMSM	Nuclear Materials and Stockpile Management
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRC	Nuclear Regulatory Commission
NRF	Naval Reactors Facility
NRHP	National Register of Historic Places
NTS	Nevada Test Site
NTS EIS	*Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada*
NWI	National Wetlands Inventory
NWPA	*Nuclear Waste Policy Act*
NWS	National Weather Service
OCRWM	Office of Civilian Radioactive Waste Management
ORISE	Oak Ridge Institute for Science and Education
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OSHA	Occupational Safety and Health Administration
PA	Protected Area
Pantex	Pantex Plant
Pantex EIS	*Environmental Impact Statement for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components*
PBF	Power Burst Facility
PCV	Primary Containment Vessel
PEIS	programmatic environmental impact statement
PEL	Permissible Exposure Level
PFP	Plutonium Finishing Plant
PFP EIS	*Plutonium Finishing Plant Stabilization Environmental Impact Statement*
PIDAS	Perimeter Intrusion Detection and Alarm System
PNNL	Pacific Northwest National Laboratory
PPA	Property Protection Area
PRA	probabilistic risk assessment
PSAR	Preliminary Safety Analysis Report
PSD	Prevention of Significant Deterioration

PUREX	Plutonium-Uranium Extraction Plant
PWR	pressurized water reactor
R&D	Research and Development
RCRA	*Resource Conservation and Recovery Act*
REA	regional economic area
RIA	reactivity insertion accident
RFETS	Rocky Flats Environmental Technology Site
RIMS II	Regional Input-Output Modeling System
RL	Richland Operations Office
ROD	Record of Decision
ROI	region of influence
RSWF	Radioactive Scrap and Waste Facility
RWMC	Radioactive Waste Management Complex
RWMS	Radioactive Waste Management Site
SAR	Safety Analysis Report
SARA	*Superfund Amendments and Reauthorization Act*
sd	standard deviation
SDWA	*Safe Drinking Water Act*
SEB	Security Equipment Building
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SISMP	Site Integrated Stabilization and Management Plan
SMR	Standardized Mortality Ratio
SNF	spent nuclear fuel
SNL	Sandia National Laboratories
SRR	standardize rate ratio
SRS	Savannah River Site
Stockpile Stewardship and Management PEIS	*Programmatic Environmental Impact Statement for Stockpile Stewardship and Management*
Storage and Disposition PEIS	*Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement*
SST	safe secure trailer
START	Strategic Arms Reduction Talks

TA	Technical Area
TAN	Test Area North
TCLP	toxicity characteristic leaching procedure
TDEC	Tennessee Department of Environmental Conservation
TDS	total dissolved solids
TI	transport index
TLV	Threshold Limit Values
TNRCC	Texas Natural Resources Conservation Commission
TRA	Test Reactor Area
TRU	transuranic
TSCA	*Toxic Substance Control Act*
TSD	Transportation Safeguards Division
TSP	total suspended particulates
TSR PEIS	*Tritium Supply and Recycling Programmatic Environmental Impact Statement*
TVA	Tennessee Valley Authority
USFWS	United States Fish and Wildlife Services
USGS	United States Geological Survey
VOC	volatile organic compound
VRM	Visual Resource Management
WAC	Waste Acceptance Criteria
Waste Management PEIS	*Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste*
WIPP	Waste Isolation Pilot Plant
WMIS	Waste Management Information System
WNP	Washington Nuclear Power
WPPSS	Washington Public Power Supply System
WSA	Weapons Storage Area
WSCC	Western Systems Coordinating Council
WSCF	Waste Sampling and Characterization Facility
Y-12	Y-12 Plant
Y-12 EA	*Environmental Assessment for the Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Level at the Y-12 Plant, Oak Ridge, Tennessee*
YMSCO	Yucca Mountain Site Characterization Office
ZPPR	Zero Power Physics Reactor

CHEMICALS AND UNITS OF MEASURE

°C	degrees Celsius
Ci	curie
cm	centimeter
CO	carbon monoxide
CO_2	carbon dioxide
Co-60	cobalt-60
Cs	cesium
Cs-137	cesium-137
CsCl	cesium chloride
Cu	copper
dB	decibel
dBA	decibel A-weighted
°F	degrees Fahrenheit
ft	feet
ft^2	square feet
ft^3	cubic feet
g	gram
G	gravitational acceleration
gal	gallon
Gd	gadolinium
GWd	gigawatt-days
ha	hectare
H_2	hydrogen
HF	hydrogen fluoride
HNO_3	nitric acid
hr	hour
I-129	iodine-129
in	inch
k_{eff}	effective neutron multiplication factor
kg	kilogram
km	kilometer
km^2	square kilometer

Kr	krypton
kV	kilovolt
l	liter
lb	pound
m	meter
m^2	square meter
m^3	cubic meter
mCi	millicurie
mg	milligram
mi	mile
mi^2	square miles
min	minute
mph	miles per hour
mrem	millirem (one thousandth of a rem)
MW	megawatt
MWe	megawatt electric
N_2	nitrogen
nCi	nanocurie (one-billionth of a Curie)
Ni	nickel
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
O_3	ozone
oz	ounce
Pb	lead
PCB	polychlorinated biphenyl
pCi	picocurie (one-trillionth of a Curie)
PM_{10}	particulate matter less than or equal to 10 microns
ppm	parts per million
Pu	plutonium
PuCl	plutonium chloride
PuO_2	plutonium dioxide
rad	radiation absorbed dose
rem	roentgen equivalent man
RfC	Reference Concentration
RfD	Reference Dose

s	second
SO_2	sulfur dioxide
Sr-90	strontium-90
t	metric ton
Tc-99	technetium-99
ton	short ton
U	uranium
U-233	uranium-233
U-234	uranium-234
U-235	uranium-235
U-236	uranium-236
U-238	uranium-238
UF_6	uranium hexafluoride
UNH	uranyl nitrate hexahydrate
UO_2	uranium dioxide
U_3O_8	triuranium octaoxide
VOC	volatile organic compound
yd	yard
yr	year
μg	microgram (one-millionth of a gram)

Metric Conversion Chart

To Convert Into Metric			To Convert Out of Metric		
If You Know	**Multiply By**	**To Get**	**If You Know**	**Multiply By**	**To Get**
Length					
inches	2.54	centimeters	centimeters	0.3937	inches
feet	30.48	centimeters	centimeters	0.0328	feet
feet	0.3048	meters	meters	3.281	feet
yards	0.9144	meters	meters	1.0936	yards
miles	1.60934	kilometers	kilometers	0.6214	miles
Area					
sq. inches	6.4516	sq. centimeters	sq. centimeters	0.155	sq. inches
sq. feet	0.092903	sq. meters	sq. meters	10.7639	sq. feet
sq. yards	0.8361	sq. meters	sq. meters	1.196	sq. yards
acres	0.40469	hectares	hectares	2.471	acres
sq. miles	2.58999	sq. kilometers	sq. kilometers	0.3861	sq. miles
Volume					
fluid ounces	29.574	milliliters	milliliters	0.0338	fluid ounces
gallons	3.7854	liters	liters	0.26417	gallons
cubic feet	0.028317	cubic meters	cubic meters	35.315	cubic feet
cubic yards	0.76455	cubic meters	cubic meters	1.308	cubic yards
Weight					
ounces	28.3495	grams	grams	0.03527	ounces
pounds	0.45360	kilograms	kilograms	2.2046	pounds
short tons	0.90718	metric tons	metric tons	1.1023	short tons
Temperature					
Fahrenheit	Subtract 32 then multiply by 5/9ths	Celsius	Celsius	Multiply by 9/5ths, then add 32	Fahrenheit

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}
hecto-	h	100 = 10^{2}
deka-	da	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}
femto-	f	0.000 000 000 000 001 = 10^{-15}
atto-	a	0.000 000 000 000 000 001 = 10^{-18}

Chapter 1
Background, Purpose of, and Need for the Proposed Action

1.1 INTRODUCTION

At the end of the Cold War, the need for nuclear materials used in weapons in the United States was significantly reduced. Substantial quantities of weapons-usable fissile materials that had previously been intended for use in warheads remain in Department of Energy (DOE) facilities. The President has declared that some quantities of fissile materials are surplus to national defense and defense-related program needs. Other materials are being retained for defense and defense-related program needs. Additional fissile materials may be declared surplus in the future. As a result, DOE is developing an integrated strategy for storage and disposition of weapons-usable fissile materials.

As the number of weapons in the stockpile is reduced, DOE is faced with the challenge of effectively managing weapons-usable fissile materials in existing inventories and those resulting from the dismantlement of nuclear weapons and weapon components. Declaration of fissile materials as surplus by the President is resulting in an inventory of fissile materials that includes all isotopes of plutonium (Pu) except Pu-238 (used in space and industrial applications), uranium-233 (U-233), and highly enriched uranium (HEU), which is uranium with a U-235 isotopic content of 20 percent or more. If not properly managed, these fissile materials could pose a danger to national and international security. DOE must manage the storage and disposition of these materials to prevent the potential for proliferation of nuclear weapons and adverse environmental, safety, and health consequences.

This *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (Storage and Disposition PEIS) analyzes the potential direct, indirect, and cumulative environmental effects of reasonable alternatives for the long-term storage of nonsurplus Pu and HEU, storage of surplus Pu and HEU pending disposition, and disposition of surplus weapons-usable Pu. [Text deleted.] A separate document, *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement* (DOE/EIS-0240 [HEU EIS]), addresses the disposition of surplus HEU. The HEU EIS Record of Decision (ROD) was published on August 5, 1996 (61 FR 40619).

A key element of DOE's decisionmaking is a thorough understanding of the environmental impacts that may occur during the implementation of the proposed action. The *National Environmental Policy Act* of 1969 (NEPA), as amended, provides Federal agency decisionmakers with a process to consider potential environmental consequences (both positive and negative) of proposed actions before making decisions. In following this process, DOE has prepared this Storage and Disposition Final PEIS to analyze various long-term storage and disposition alternatives and to provide the necessary background, data, and analyses to help decisionmakers and the public understand the potential environmental impacts of each alternative. The results of the environmental analyses, together with information from technical and economic studies, the nonproliferation analysis, and public input, will form the basis for DOE's decisions, which will be discussed in an ROD to be issued no sooner than 30 days after publication of this Storage and Disposition Final PEIS.

1.1.1 WEAPONS-USABLE FISSILE MATERIALS

Locations in the United States. The Department's inventories of Pu and HEU are located at a number of DOE sites, including the Hanford Site (Hanford), Idaho National Engineering Laboratory (INEL), Lawrence Livermore National Laboratory (LLNL), Los Alamos National Laboratory (LANL), Oak Ridge Reservation (ORR), the Pantex Plant (Pantex), Rocky Flats Environmental Technology Site (RFETS), and Savannah River

Site (SRS). [Text deleted.] The weapons-usable Pu materials are those that can be readily converted for use in nuclear weapons, including weapons-grade, fuel-grade, and power reactor-grade Pu. Inventories and locations of currently declared surplus weapon-grade Pu and surplus HEU, as stated in DOE's Openness Initiative of February 6, 1996, are presented in Figures 1.1.1–1 and 1.1.1–2, respectively. These materials, currently declared excess to national security needs, total approximately 38.2 metric tons (t) (42.1 short tons [tons]) of weapons-grade Pu and 174.3 t (192.1 tons) of HEU. As of September 1994, the total U.S. inventory of Pu is composed of 85 t (93.7 tons) of weapons-grade material,[1] 13.2 t (14.6 tons) of fuel grade, and 1.3 t (1.4 tons) of power reactor grade (DOE 1996p:17). [Text deleted.]

Materials Covered in This Programmatic Environmental Impact Statement. All Pu (except for Pu-238 and Department of Defense [DoD] weapons program materials in use) and nonsurplus HEU (except DoD weapons program materials in use) are being considered for the various long-term storage alternatives. The Pu materials being considered for disposition in this PEIS are those the President has declared surplus or may declare surplus to national defense needs in the future in response to recommendations from the Nuclear Weapons Council (made up of representatives from DOE, DoD, and the Joint Chiefs of Staff). For the purposes of analysis, this PEIS analyzes the disposition of a nominal 50 t (55.1 tons) of Pu. The Pu materials covered in this PEIS are primarily in the form of pits (Pu-bearing weapons components), metals, and oxides.

The Department is currently in the process of stabilizing and repackaging weapons-usable fissile materials and placing them in safe, secure interim storage awaiting decisions on long-term storage and disposition. For Pu, this is being accomplished in accordance with the corrective actions identified in DOE's *Plutonium Vulnerability Management Plan* (DOE/EM-0199). This plan was developed in response to an assessment in DOE's *Plutonium Working Group Report* (DOE/EH-0415) and recommendations by the Defense Nuclear Facilities Safety Board (DNFSB) to improve the schedule for interim safe storage at those sites where Pu is currently stored (DNFSB 94-1). These corrective actions include material packaging upgrades and standardized packaging to facilitate cost-effective management of materials well into the future. This will be the base condition and storage configuration from which decisions will be made on future storage. In addition, the Pu materials will also meet the *Criteria for Safe Storage of Plutonium Metals and Oxides* (DOE-STD-3013-94), a DOE standard for long-term storage (at least 50 years) of these materials. Fissile materials present in spent nuclear fuel or irradiated targets[2] from reactors are not covered in this PEIS; they are not considered weapons-usable because separation of the relevant isotopes from these highly radioactive materials requires significant remote chemical processing. Any subsequent reprocessing and extraction of Pu from spent fuel is beyond the scope and the fundamental nonproliferation purpose of the program covered by this PEIS.

Following the discontinuance of nuclear weapons material production, large quantities of residues remained as a result of the chemical and thermal processes applied to separate and purify Pu. Examples of residue forms include some impure oxides and metals, halide salts, combustibles, ash, sludges, and contaminated glass. To meet requirements of DOE's *Plutonium Vulnerability Management Plan*, as well as various compliance agreements with State and local regulatory agencies, some Pu residues must be stabilized. As a result of the stabilization process, portions of the residues will potentially be concentrated and stored. These concentrates may be in a form and concentration (greater than 50 percent Pu by weight) that is weapons-usable and are therefore included in this PEIS.[3]

The stabilization, concentration, and storage of Pu residues, as well as disposal of non-weapons-usable waste, is covered in other existing and future environmental documents as appropriate, including the *Final Environmental Impact Statement, Interim Management of Nuclear Materials* (at SRS) and ROD; the *Plutonium*

[1] Weapons-grade Pu contains less than 7 percent Pu-240, fuel grade Pu contains from 7 to less than 19 percent Pu-240, and power reactor grade Pu contains 19 percent and greater Pu-240.

[2] These materials are not directly subject to disposition pursuant to this PEIS unless the irradiated fuel or targets were first processed to separate the Pu under another program. Currently, DOE is not proposing such an action.

[3] As a result of the stabilization process, there will also be nonweapons-usable Pu or HEU contaminated wastes or residues (less than 50 percent Pu by weight) that would not be within the scope of this PEIS.

Finishing Plant Stabilization Final Environmental Impact Statement (at Hanford) and ROD; the *Environmental Assessment for Solid Residue Treatment, Repackaging, and Storage (at RFETS)* and Finding of No Significant Impact (FONSI); and an EIS on the *Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site* (in preparation), as discussed in Section 1.4. [Text deleted.]

The nonsurplus HEU materials covered in this PEIS are primarily in the form of metals and oxides. These materials include naval nuclear fuel feed stock, strategic reserves, and programmatic materials. Storage of surplus HEU, pending disposition under the HEU EIS and ROD, is also analyzed.[4] The HEU materials for long-term storage will meet long-term storage criteria for safe storage of HEU metals and oxides, which are under development at this time. Appropriate environmental review will be prepared for stabilizing and repackaging the HEU materials to meet respective long-term storage criteria.

1.2 BACKGROUND

The arms race between the superpowers was brought to a close at the end of the Cold War, causing increases in stockpiles of surplus weapons-usable fissile materials. Continued implementation of arms reduction agreements may lead to additional quantities being declared surplus in the future. With the collapse of the Soviet Union and the economic and social challenges faced by newly formed states, there is a serious risk of nuclear proliferation from those growing stockpiles. The United States has taken steps to address this risk of nuclear proliferation. In September 1993, President Clinton announced the *Nonproliferation and Export Control Policy* (see Appendix A), which included the commitment that the United States will do the following:

- Seek to eliminate, where possible, the accumulation of stockpiles of HEU or Pu, and to ensure that, where these materials already exist, they are subject to the highest standards of safety, security, and international accountability.

- Initiate a comprehensive review of long-term options for Pu disposition, taking into account technical, nonproliferation, environmental, budgetary, and economic considerations. Russia and other nations with relevant interests and experience will be invited to participate in the study.

Following the President's policy announcement, the National Security Council, together with the White House Office of Science & Technology Policy, established an Interagency Working Group (IWG) to initiate a comprehensive review of the options for disposition of surplus Pu from nuclear weapons activities. Members of the IWG include the Arms Control and Disarmament Agency, Environmental Protection Agency (EPA), DNFSB, Nuclear Regulatory Commission (NRC), Office of Management and Budget, DOE, Department of State, and DoD. DOE has the lead role within the IWG for evaluating technical options and conducting economic, schedule, and environmental analyses.

At the Moscow Summit in January 1994, President Clinton and President Yeltsin issued the *Joint Statement by the President of the Russian Federation and the President of the United States of America on Non-Proliferation of Weapons of Mass Destruction and the Means of Their Delivery* (see Appendix A). The two Presidents agreed to task their technical experts to study options for the disposition of weapons-usable fissile materials, including Pu, taking into account the issues of nonproliferation, environmental protection, safety, and technical and economic factors. Under the leadership of the IWG, an initial meeting was held in Moscow in May 1994 to establish the framework for this effort. DOE and its national laboratories have assumed the lead technical role in supporting this joint effort.

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[4] This Storage and Disposition PEIS covers long-term storage of nonsurplus HEU and storage of surplus HEU pending disposition. Until storage decisions are implemented, surplus HEU that has not gone to disposition will continue to be stored pursuant to, and not to exceed the 10-year interim storage time period evaluated in the *Environmental Assessment for the Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Storage Level at the Y–12 Plant, Oak Ridge, Tennessee* (DOE/EA-0929, September 1994) and Finding of No Significant Impact. [Text deleted.]

At the end of January 1995, specialists from the United States and Russia met at LANL for a 2-day exchange of technical presentations on scientific research that had been conducted on potential Pu disposition alternatives and on promising prospective investigations. During this meeting, the United States and Russia reviewed various long-term storage and disposition options. Both sides agreed to conduct consistent comparisons of alternatives for the disposition of Pu, taking into account the factors noted in the Summit statement of the two Presidents.

In addition, DOE sponsored a National Academy of Sciences (NAS) study on the management and disposition of surplus weapons Pu. In its report, *Management and Disposition of Excess Weapons Plutonium* of March 1994, the NAS stated that the existence of surplus weapons-usable fissile materials was a "clear and present danger to national and international security" and then identified proposed standards for managing the risks associated with surplus weapons-usable fissile materials (NAS 1994a:vii,31-34). The following standards, although not regulatory requirements, were identified by the NAS and modified by DOE:

- *The Stored Weapons Standard.* The high standards of security and accounting for the storage of intact nuclear weapons should be maintained, to the extent practical, for weapons-usable fissile materials throughout dismantlement, storage, and disposition. [Text deleted.]

- *The Spent Fuel Standard.* The surplus weapons-usable Pu should be made as inaccessible and unattractive for weapons use as the much larger and growing quantity of Pu that exists in spent nuclear fuel from commercial power reactors.

The NAS also identified several disposition options that meet these standards, including immobilization of Pu for disposal and the use of Pu in mixed oxide (MOX) fuel for commercial (non-defense) nuclear reactors. Material forms resulting from the immobilization and reactor options would be disposed of in a high-level waste (HLW) repository. The NAS also identified the deep borehole as a possible disposition option, where ultimate disposal is accomplished by emplacing the Pu material several kilometers below the water table into ancient, geologically stable rock formations. DOE used the NAS report as the starting point for developing the proposed action for disposition of surplus Pu.

More recently, through the ongoing efforts of the joint U.S./Russia study, the *Joint United States/Russian Plutonium Disposition Study* on technical options for the disposition of surplus Pu was issued in late September 1996. This study was undertaken to provide a consistent comparison of deep borehole, immobilization, and reactor alternatives by the two countries using criteria related to nuclear nonproliferation, safety, environmental protection, and technical and economic factors. Joint technical demonstrations are planned by the United States and Russia to support implementation of disposition decisions. The study and options will provide decisionmakers from both countries with a set of jointly evaluated alternatives for Pu disposition and help build further trust and cooperation in the area of fissile materials disposition.

1.3 PURPOSE OF AND NEED FOR THE PROPOSED ACTION

The Department proposes to take the following actions for U.S. weapons-usable fissile materials:

- Storage—provide a long-term storage system (for up to 50 years) for nonsurplus Pu and HEU that meets the Stored Weapons Standard and applicable environmental, safety, and health standards while reducing storage and infrastructure[5] costs

- Storage Pending Disposition—provide storage that meets the Stored Weapons Standard for inventories of weapons-usable Pu and HEU that have been or may be declared surplus

[5] Includes electrical power, fuel, transportation network requirements, and safeguards/security.

- Disposition—convert surplus Pu and Pu that may be declared surplus in the future to forms that meet the Spent Fuel Standard, thereby providing evidence of irreversible disarmament and setting a model for proliferation resistance

[Text deleted.]

The purpose of the proposed action is to implement the President's *Nonproliferation and Export Control Policy* in a safe, reliable, cost-effective, and timely manner. DOE is proposing a comprehensive program to accomplish this purpose by providing an exemplary long-term storage system for weapons-usable fissile materials, eliminating the stockpile of surplus weapons-usable Pu, and establishing the technical and program infrastructure that will enable the United States to dispose of surplus weapons-usable Pu.

A portion of the materials covered in this Storage and Disposition Final PEIS may be subject to international and/or bilateral inspection. Consistent with the President's *Nonproliferation and Export Control Policy*, surplus fissile materials will be subject to international inspections, including inspections by the International Atomic Energy Agency (IAEA), with the imperative that there would be no disclosure of sensitive/classified information to unauthorized parties. Furthermore, in an effort to increase transparency between the United States and Russia on nuclear disarmament, some nonsurplus materials may be made available for bilateral inspections with the Russians, once an agreement is reached between the two countries. Facilities for long-term storage and disposition would be designed or modified, as needed, to accommodate inspection requirements. Other modifications to those facility designs might be needed should new treaties come into effect.

In March 1995, the President declared 200 t (220 tons) of fissile materials to be surplus to national defense needs. These materials are in various compositions and forms. A long-term storage plan is needed to provide continued and adequate control of these surplus materials and any that may be declared surplus in the future, from now through disposition. Disposition of surplus Pu is needed to reduce the reliance on institutional controls and to provide visible evidence of irreversible disarmament. A comprehensive long-term storage and disposition action is needed to ensure that weapons-usable fissile materials are properly managed and to prevent the increase of potential environmental, health, and safety risks. This includes achieving nonproliferation goals through the disposition of surplus Pu, providing long-term storage for nonsurplus Pu and HEU, and providing storage for surplus Pu and HEU that cannot go directly from current storage to disposition. DOE also recognizes the need to strengthen national and international arms control efforts by providing a storage and disposition model for the international community. This action will enhance U.S. credibility and flexibility in negotiations on bilateral or multilateral reductions of surplus weapons-usable fissile materials inventories.

1.4 RELATED *NATIONAL ENVIRONMENTAL POLICY ACT* REVIEWS

Weapons-usable fissile materials are divided into two categories—surplus and nonsurplus. The nonsurplus category includes naval nuclear fuel, strategic reserves, programmatic materials (non-weapons research and development [R&D], weapons R&D, and other programmatic materials), and weapons program materials in use (as shown in Figure 1.4–1). Weapons program materials in use will not go into long-term storage. These materials are primarily located in weapons and operational storage vaults at current DoD weapons complex sites. For this reason, these materials are not analyzed for long-term storage. The ongoing and completed environmental reviews related to the storage and disposition of weapons-usable fissile materials, both Pu and HEU, are summarized in Table 1.4–1. A description of these and other related environmental reviews is given below.

Current or Interim Storage. The *Final Environmental Impact Statement for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components* (Pantex EIS, DOE/EIS-0225, November 1996), is a sitewide EIS that covers current and proposed facilities and activities at Pantex in Amarillo, Texas, where Pu pits are currently stored. The Pantex EIS analyzes the alternatives and environmental impacts associated with conducting nuclear weapons operations at Pantex for approximately 10 years. Included in the

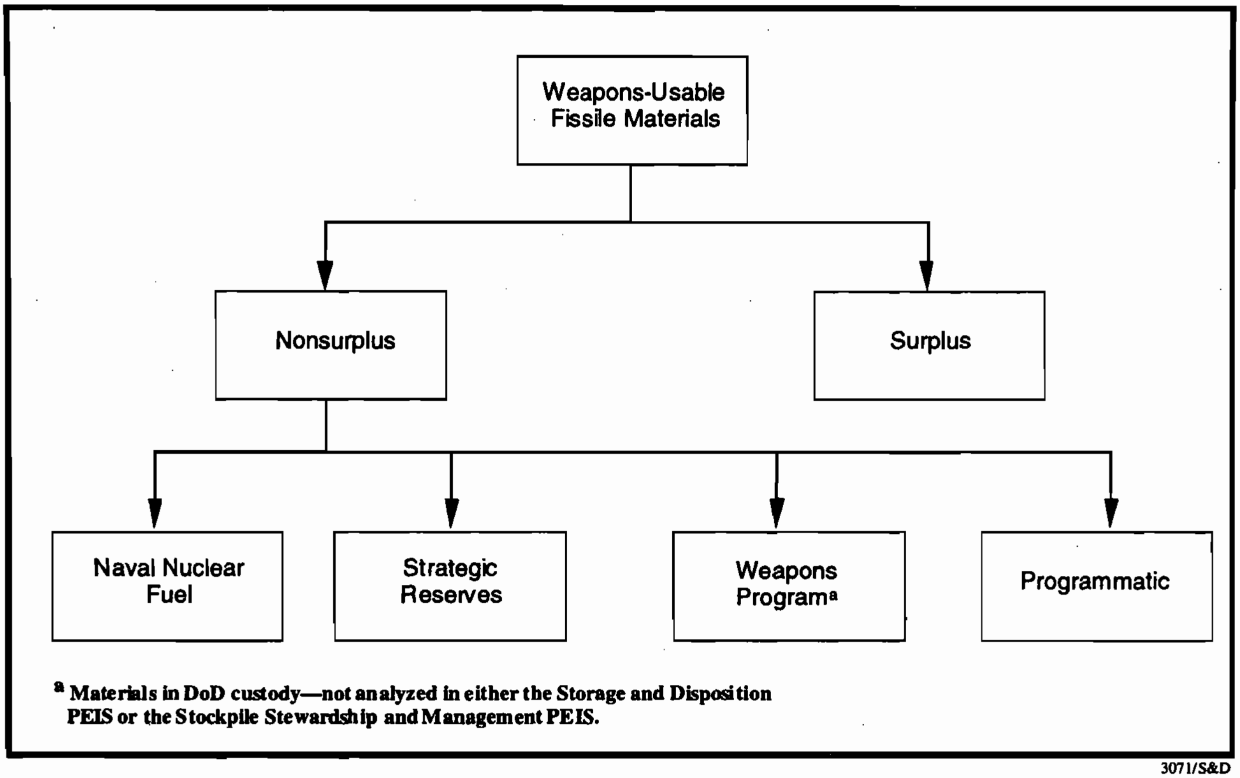

Figure 1.4–1. Weapons-Usable Fissile Material Categories.

Pantex EIS is an analysis to increase the interim storage of Pu pits from 12,000 pits to 20,000 pits. The Pantex EIS also analyzes alternate locations to Pantex for interim pit storage operations.

In May 1994, when DOE announced its intention to prepare the Pantex EIS, DOE believed that the Pantex EIS ROD would precede decisionmaking on the long-term storage of pits. Accordingly, the Pantex EIS was scoped to address alternate locations for interim pit storage (that is, until the long-term decisions are made and implemented).

The *Environmental Assessment for the Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Storage Level at the Y–12 Plant, Oak Ridge, Tennessee* (Y–12 EA) (DOE/EA-0929) evaluates the continued receipt, prestorage processing, and interim storage of enriched uranium for up to 10 years in quantities that would exceed the historical maximum storage level. The Y–12 EA was issued in September 1994 and was followed by a FONSI in September 1995. In the FONSI, DOE determined that the Y–12 Plant (Y–12) would store no more than 500 t (550 tons) of HEU and no more than 6 t (6.6 tons) of low-enriched uranium (LEU).

The *Interim Storage of Plutonium at the Rocky Flats Environmental Technology Site Environmental Impact Statement*, announced for preparation by DOE on July 17, 1996 (61 FR 37247), will evaluate reasonable alternatives for the safe interim storage of Pu at RFETS, including current and additional inventory from future processing of Pu residues into more stable forms, pending implementation of upcoming long-term storage and disposition decisions, and waste management decisions.

The *Environmental Assessment for Solid Residue Treatment, Repackaging, and Storage* (DOE/EA-1120, April 1996) describes and analyzes the environmental effects of the proposed action to treat, repackage, and provide interim storage of solid residues at RFETS. It also analyzes the alternatives of taking no action, shipping the

Table 1.4–1. Environmental Reviews for Storage and Disposition of Weapons-Usable Fissile Materials

Action	Pu	HEU
Current/Interim Storage	Pantex EIS[a] and other site-specific NEPA documents (see Table 1.4–2)	Y–12 EA[b]
Long-Term Storage	Storage and Disposition PEIS Stockpile Stewardship and Management PEIS[c]	Storage and Disposition PEIS Stockpile Stewardship and Management PEIS[c]
Disposition	Storage and Disposition PEIS	HEU EIS[d]
[Text deleted.]		

[a] *Final Environmental Impact Statement for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components* (DOE/EIS-0225, November 1996).
[b] *Environmental Assessment for the Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Storage Level at the Y-12 Plant, Oak Ridge, Tennessee* (DOE/EA-0929, September 1994).
[c] *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (DOE/EIS-0236, September 1996).
[Text deleted.]
[d] *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement* (DOE/EIS-0240, June 1996).

residues offsite for treatment, and shipping the residues offsite for storage. A FONSI to the environmental assessment (EA) was signed by DOE in April 1996.

On November 19, 1996, DOE announced its intention to prepare an EIS on the *Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site* (61 FR 58866). This EIS will evaluate the potential environmental impacts associated with reasonable management alternatives for certain Pu residues and all scrub alloy currently being stored at RFETS. The management alternatives include treatment of these materials to enable them to be disposed of as waste or, in the case of separated surplus weapons-usable Pu, stored and dispositioned in accordance to the decisions to be made in the Storage and Disposition PEIS ROD. Activities analyzed in this EIS would be in addition to certain activities evaluated in the *Environmental Assessment for Solid Residue Treatment, Repackaging, and Storage*, previously described, in which a portion of the residues would undergo further treatment prior to waste disposal or other disposition.

Long-Term Storage. With the exception of those materials in weapons programs, the Storage and Disposition PEIS analyzes the environmental impacts of reasonable alternatives for long-term storage of various materials in all categories shown in Figure 1.4–1, including the long-term storage of all Pu pits (strategic reserves and surplus) and the approach for dispositioning pits that are surplus to national security requirements.

Another DOE NEPA document that addresses the storage of pits is the *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (Stockpile Stewardship and Management PEIS, DOE/EIS-0236, September 1996). The Stockpile Stewardship and Management PEIS supports decisions on the long-term storage of pits that will be needed for national security requirements (strategic reserve pits). The Preferred Alternative for strategic reserve storage is as follows: (1) HEU strategic reserve storage at Y–12 and (2) Pu pits strategic reserve storage in Zone 12 at Pantex. It also calls for the weapons R&D material (Pu-242), to be stabilized at SRS as a result of the ROD for the *Final Environmental Impact Statement, Interim Management of Nuclear Materials* (DOE/EIS-0220, October 1995), to be transported to LANL for storage.

Table 1.4–2. Additional Environmental Reviews Related to the Storage and Disposition Programmatic Environmental Impact Statement

Site	Document	Status
Argonne National Laboratory-West, Idaho Falls, ID	Electrometallurgical Treatment Research and Demonstration Project in the Fuel Conditioning Facility at ANL-West EA	Final 5/96
Hanford Site, Richland, WA	Plutonium Finishing Plant Stabilization EIS	Final 5/96
Los Alamos National Laboratory, Los Alamos, NM	Los Alamos National Laboratory Site-Wide EIS	In preparation
Multiple DOE sites	Waste Management PEIS	Draft 8/95 Final in preparation
Nevada Test Site, Mercury, NV	Nevada Test Site and Off-Site Locations in the State of Nevada EIS	Final 8/96
Rocky Flats Environmental Technology Site, Golden, CO	Interim Storage of Plutonium at the Rocky Flats Environmental Technology Site EIS	In Preparation
Rocky Flats Environmental Technology Site, Golden, CO	Solid Residue Treatment, Repackaging, and Storage EA	Final 4/96
Rocky Flats Environmental Technology Site, Golden, CO	Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site EIS	In preparation
Savannah River Site, Aiken, SC	Defense Waste Processing Facility, Supplemental EIS	Final 11/94
Savannah River Site, Aiken, SC	F-Canyon Plutonium Solutions EIS	Final 12/94
Savannah River Site, Aiken, SC	Savannah River Site Waste Management EIS	Final 7/95
Savannah River Site, Aiken, SC	Interim Management of Nuclear Materials EIS	Final 10/95
Savannah River Site, Aiken, SC	Tritium Supply and Recycling PEIS	Final 10/95

Since the Stockpile Stewardship and Management Program may store strategic materials and weapons R&D material, this Storage and Disposition Final PEIS separately analyzes, as a subpart of each alternative, the long-term storage of weapons-usable fissile materials without strategic reserves and weapons R&D material (under the programmatic category in Figure 1.4–1). Preparation of this Storage and Disposition Final PEIS and the Stockpile Stewardship and Management PEIS has been closely coordinated to ensure that all necessary information is available to the decisionmaker. Both of these PEISs have progressed to the point where they are scheduled to have their RODs issued in late 1996 or early 1997. Decisions on the long-term storage of pits would be made in the RODs of the PEISs. A decision relating to the interim storage of pits at Pantex would be made in the ROD of the Pantex EIS pending implementation of the selected long-term storage alternative(s).[6]

Disposition. The Storage and Disposition PEIS addresses the disposition of surplus Pu. In the *Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling* (TSR PEIS, DOE/EIS-0161, October 1995), there is an option for a multipurpose reactor that could produce tritium, use Pu in reactor fuel, and generate revenue through the production of electricity. Environmental analysis of the multipurpose reactor

[6] If there is a delay in implementing the RODs for either of the PEISs (for example, delay due to availability and construction of upgrades for long-term storage facilities), then there would be a need to make a decision on the location of interim storage of pits. The Pantex EIS has been completed with the analysis of interim storage alternatives, including the issues and comments received from the public on that EIS, to support a decision relating to the storage of pits until a long-term storage decision is made and implemented.

is included in the TSR PEIS. On December 6, 1995, the Secretary of Energy made the decision that the future source of tritium would either be from a purchased reactor, from irradiation in a commercial reactor, or from the accelerator production of tritium. The multipurpose reactor was preserved as an option for future consideration. Therefore, the multipurpose reactor, as well as the Fast Flux Test Facility (FFTF) at Hanford, are discussed in Appendix N of this Storage and Disposition Final PEIS.

For the disposition of surplus HEU, DOE's decision, as identified in the HEU EIS ROD, is to gradually blend down a nominal 200 t (220 tons) of HEU[7] to LEU, containing less than 20 percent of the U-235 isotope, with the potential use of up to 85 percent of the resulting LEU as non-defense reactor fuel feed. The remaining LEU produced by blend-down would be disposed of as low-level waste (LLW). The blending down of the HEU will occur over an estimated 15- to 20-year period, with continued storage of the HEU until blend-down. The proposed action was analyzed separately in the HEU EIS from that of the Storage and Disposition PEIS because the disposition of surplus HEU can be accomplished at existing facilities and with existing technologies, and would involve different alternatives, timeframes, technologies, facilities, and personnel than those required for Pu disposition. The surplus HEU is part of the larger HEU inventory that was analyzed for interim storage in the Y-12 EA. [Text deleted.]

Other Related Environmental Reviews. The *Draft Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (Waste Management PEIS, DOE/EIS-0200D, August 1995) addresses management of the current and 20-year projected inventories of five types of waste (high-level, transuranic, low-level, low-level mixed, and hazardous waste) on a national basis. Among other things, it identifies impacts of consolidating or not consolidating waste management operations across sites where DOE manages wastes. [Text deleted.]

Waste management assumptions in this Storage and Disposition PEIS are based on current practice. These practices may be changed by the waste-type specific RODs from the Waste Management PEIS. However, none of the alternatives analyzed in this PEIS are expected to result in waste forms or produce "end product" materials that are not covered in the Waste Management PEIS.

Additional site-specific environmental reviews are currently being prepared by DOE. A listing of these reviews is included in Table 1.4–2. In particular, the site-specific, sitewide EISs being prepared cover continued operations for some of the sites evaluated in this Storage and Disposition PEIS. Some of the existing activities covered by these EISs are also similar to those of the No Action Alternative analyzed in this Storage and Disposition PEIS. Although the near-term analytical periods for these sitewide EIS analyses may be different from that of this Storage and Disposition PEIS, which is focused on longer-term activities, the preparation of these documents has been closely reviewed and coordinated within DOE.

As work on these and other potentially related NEPA documents proceeds, information from such future NEPA documents will be incorporated, as appropriate, in any supplements to, or documents tiered from, this Storage and Disposition Final PEIS.[8]

1.5 DECISIONS TO BE MADE

From March 8 through June 7, 1996, the Storage and Disposition Draft PEIS was circulated for written and oral comments from other Federal government agencies, State and local governments, Native American tribes,

[7] The nominal 200 t (220 tons) of HEU addressed in the HEU EIS consists of HEU already declared surplus, plus HEU that may be declared surplus in the future. This is different from and should not be confused with the 200 t (220 tons) of fissile material currently declared surplus by the President, which includes both HEU and Pu.

[8] The other ongoing or completed NEPA reviews referenced in Section 1.4 of this PEIS involve different purposes, needs, and alternative actions. They also involve, in whole or in part, different workers, locations, affected environments, and timing. As such, this PEIS is independently justified, and can and should proceed regardless of actions taken pursuant to other NEPA reviews. Except for tiered NEPA reviews, the decisions pursuant to this PEIS will not automatically trigger other actions requiring NEPA review.

special interest groups, and the public. Public meetings in the vicinity of the sites under consideration for the proposed action and in Washington, DC were held during the comment period. The comments received, along with DOE's responses, became a part of this Storage and Disposition Final PEIS. The Department also made available the results of the technical, cost, and schedule analyses[9,10] in July and November 1996, (DOE 1996o:ES-1–ES-14; DOE 1996r: ES-1–ES-8) and the nonproliferation analysis[11] in October 1996. Taken together, these analyses will support a formal ROD regarding Pu and HEU storage and Pu disposition. [Text deleted.] These decisions are as follows:

For storage:

- The strategy for long-term storage of nonsurplus weapons-usable Pu and nonsurplus HEU
- The strategy for storage of surplus Pu and surplus HEU until disposition
- The storage site(s) and (if appropriate) facilities

For disposition:

- The strategy and technologies for disposition of surplus weapons-usable Pu

The Department, with interagency coordination, will then issue the ROD. Following the ROD, subsequent tiered and project-specific NEPA documents will be prepared. The tiered NEPA reviews will analyze alternative locations for disposition activities.

1.6 PREFERRED ALTERNATIVE

STORAGE

The Department's Preferred Alternative for storage is to reduce, over time, the number of locations where the various forms of Pu are stored, through a combination of storage alternatives in conjunction with a combination of disposition alternatives. DOE would begin implementing this Preferred Alternative by moving surplus Pu from RFETS as soon as possible, transporting the pits to Pantex as early as 1997, and the non-pit Pu materials to SRS beginning in 2002. Over time, DOE would store Pu in upgraded facilities at Pantex and in an expanded, planned new facility at SRS, and store nonsurplus HEU and surplus HEU pending disposition in upgraded and consolidated facilities at ORR. Storage facilities would also be modified, as needed, to accommodate international inspection requirements consistent with the President's *Nonproliferation and Export Control Policy*. Accordingly, DOE's Preferred Alternative for storage would call for the following actions:

- **Phase out storage of all weapons-usable Pu at RFETS beginning in 1997; move pits to Pantex, and non-pit materials to SRS.** At Pantex, DOE would repackage pits from RFETS in Zone 12, then place them in existing storage facilities in Zone 4, pending completion of facility upgrades in Zone 12. At SRS, DOE would expand the planned new Actinide Packaging and Storage Facility (APSF), and move non-pit Pu materials from RFETS, after stabilization at RFETS, to the expanded APSF upon completion. The small number of pits currently at RFETS that are not in shippable form would be placed in a shippable condition in accordance with existing procedures prior to shipment to Pantex. Additionally, some pits and non-pit Pu materials from RFETS could be used at SRS, LANL, and LLNL for tests and demonstrations of aspects of disposition technologies (see Preferred

[9] *Technical Summary Report for Surplus Weapons-Usable Plutonium Disposition* (DOE/MD-0003, Rev. 1, October 31, 1996).
[10] *Technical Summary Report for Long-Term Storage of Weapons-Usable Fissile Materials* (DOE/MD-0004, Rev. 1, November 1996).
[11] *Nonproliferation and Arms Control Assessment of Weapons-Usable Fissile Material Storage and Plutonium Disposition Alternatives* (Draft, October 1996).

Alternative for disposition as discussed later in this section). All non-pit weapons-usable Pu materials currently stored at RFETS are surplus.

- **Upgrade storage facilities at Zone 12 South (to be completed by 2004) at Pantex to store those pits currently stored at Pantex, and pits from RFETS, pending disposition. Storage facilities at Zone 4 would continue to be used for these pits prior to completion of the upgrade.** This action would place pits at a central location where most pits already reside and where expertise and infrastructure exist to accommodate pit storage.

- **In accordance with the Preferred Alternative in the Stockpile Stewardship and Management PEIS, store Strategic Reserve pits at Pantex in the facilities discussed above. To the extent not reflected above, store Strategic Reserve materials in accordance with the Preferred Alternative in the Stockpile Stewardship and Management PEIS.**

- **Expand the APSF (Upgrade Alternative) at SRS to store those surplus, non-pit Pu materials currently at SRS and surplus non-pit Pu materials from RFETS, pending disposition** (see Preferred Alternative for disposition as discussed later in this section). The APSF would be built by 2001 pursuant to the *Final Environmental Impact Statement, Interim Management of Nuclear Materials* (DOE/EIS-0220) and ROD, and the expansion to accommodate RFETS material would be completed by 2002. The RFETS surplus non-pit Pu materials would be moved to SRS after stabilization is performed at RFETS under corrective actions in response to recommendation 94-1 by the DNFSB, and after completion of the APSF expansion. This action would place non-pit Pu materials in a new storage facility, in a location with existing expertise and Pu handling capabilities, and where potential disposition activities could occur (see Preferred Alternative for disposition as discussed later in this section). Strategic Reserve pits currently located at SRS would be stored in accordance with the Preferred Alternative in the Stockpile Stewardship and Management PEIS. There are no Strategic Reserve non-pit materials currently located at SRS.

- **Continue current storage (No Action) of surplus Pu at Hanford and INEL, pending disposition** (or movement to lag storage[12] at the disposition facilities). This action would allow surplus Pu to remain at the sites with existing expertise and Pu handling capabilities, and where potential disposition activities could occur (see Preferred Alternative for disposition as discussed later in this section). There are no nonsurplus weapons-usable Pu materials currently stored at either site.

- **Continue current storage (No Action) of surplus Pu at LANL, pending disposition** (or movement to lag storage at the disposition facilities). This Pu would be stored in stabilized form with the nonsurplus Pu in the upgraded Nuclear Material Storage Facility pursuant to the No Action Alternative for the site.

- **Take No Action at the Nevada Test Site (NTS).** DOE would not add Pu to sites that do not currently have Pu in storage.

- **Upgrade storage facilities at Y–12 (to be completed by 2004 or earlier) at ORR to store nonsurplus HEU and surplus HEU pending disposition.** Existing storage facilities at Y–12 would be modified to meet natural phenomena requirements, as documented in *Natural Phenomena Upgrade of the Downsized/Consolidated Oak Ridge Uranium/Lithium Plant Facilities* (Y/EN-5080, 1994). Storage facilities would be consolidated and the storage footprint would be reduced as surplus HEU is dispositioned and blended to LEU, pursuant to the HEU EIS. Consistent with the Preferred Alternative in the Stockpile Stewardship and Management PEIS, HEU strategic reserves would be stored at Y–12.

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[12] Lag storage is temporary storage at the applicable disposition facility.

DISPOSITION

The Department's Preferred Alternative for the disposition of surplus Pu is to pursue a disposition strategy that allows for immobilization of surplus weapons Pu in glass or ceramic forms and burning of the surplus Pu as MOX fuel in existing reactors. The disposition of the surplus Pu using these technological approaches would depend on the results of future technology development and demonstrations, site-specific environmental analyses, and detailed cost proposals as well as nonproliferation considerations. The results of these efforts and negotiations with Russia and other nations will ultimately determine the timing and extent to which either or both technologies are deployed.[13]

Under this Preferred Alternative, the U.S. policy not to encourage the civil use of Pu and, accordingly, not to itself engage in Pu reprocessing for either nuclear power or nuclear explosive purposes will not change. Although under the Preferred Alternative some Pu may ultimately be burned in existing reactors, every possible means will be pursued to ensure that Federal support for this unique disposition mission does not encourage other civil uses of Pu or Pu reprocessing. The United States, however, will maintain its commitments regarding the use of Pu in civil nuclear programs in Western Europe and Japan.

Proceeding with this strategy would provide increased flexibility to initiate Pu disposition promptly, and help assure disposition efforts could be accomplished in a timely manner. Establishing the means for expeditious Pu disposition would also help provide the basis for an international cooperative effort that can result in reciprocal, irreversible Pu disposition actions by Russia. DOE's preferred disposition strategy signals a strong U.S. commitment to reducing its stockpile of surplus Pu, thereby effectively meeting the purpose of and need for the Proposed Action.

To accomplish the Pu disposition mission, DOE would consider, to the extent practical, new as well as modified existing buildings and facilities for portions of the disposition activities. The PEIS analyzes new facilities for most disposition alternatives to obtain bounding environmental impacts. DOE would analyze and compare existing and new buildings and facilities for the technologies chosen as part of this strategy in subsequent, tiered NEPA review. In addition, all disposition facilities would be designed or modified, as needed, to accommodate international inspection requirements consistent with the President's *Nonproliferation and Export Control Policy*. Accordingly, DOE's Preferred Alternative for Pu disposition involves the following strategy and supporting actions:

- **Immobilize Pu materials using vitrification or ceramic immobilization.** The immobilization technology could be used for processing pure or impure forms of Pu. Vitrification or ceramic immobilization could include the can-in-canister variant, which could utilize the existing HLW and the Defense Waste Processing Facility (DWPF) at SRS, or new facilities at Hanford or SRS. DOE would continue the R&D leading to the demonstration of the can-in-canister variant at the DWPF using surplus Pu.

- **Convert Pu materials into MOX fuel for use in existing reactors.** Pure materials including pits, pure metal, and oxides could be converted without extensive processing into MOX fuel for use in existing commercial reactors. Other, already separated forms of surplus Pu would require additional cleanup (not reprocessing of spent nuclear fuel). The MOX fuel would be used in existing light water reactors (LWRs) with a once-through fuel cycle, with no reprocessing and subsequent reuse of the spent fuel. If partially completed LWRs were to be completed by other parties, they would be considered for this mission. The MOX fuel would be fabricated in a domestic, government-owned facility at a DOE site.

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[13] Through these efforts, the President would be provided the basis and flexibility to initiate disposition efforts either multilaterally or bilaterally through negotiations or unilaterally as an example to Russia and other nations.

The Department would retain using MOX fuel in Canadian Deuterium Uranium (CANDU) reactors in Canada in the event that a multilateral agreement to use CANDU reactors is negotiated among Russia, Canada, and the United States. The DOE would engage in a test and demonstration for CANDU MOX fuel as appropriate and consistent with future cooperative efforts with Russia and Canada.

With regard to the above, for purposes of analysis of an approach involving a combination of both technologies, approximately 70 percent of the surplus Pu was identified to be in forms (metals and other pure forms) suitable for MOX fuel. The actual percentage and timing for disposition of the surplus Pu using either or a combination of both of the technological approaches would depend on the results of international agreements, future technology development and demonstrations, site-specific environmental assessments, and detailed cost proposals to be completed within the next 2 years. The results of these efforts, as well as nonproliferation considerations and negotiations with Russia and other nations, will ultimately determine the timing and extent to which either or both technologies are deployed for disposition of surplus Pu. In the event both technologies are deployed, and because the time required for Pu disposition using reactors would be longer than that for immobilization, it is probable that some surplus Pu would be immobilized initially, prior to completion of reactor irradiation for other surplus Pu. Deployment of this strategy would involve the following supporting actions:

- **Constructing and operating a Pu vitrification or ceramic immobilization facility at either Hanford or SRS.** DOE would analyze alternative locations at these two sites for constructing new or potentially using modified existing buildings in subsequent tiered NEPA review. SRS has existing facilities and infrastructure to support an immobilization mission, and Hanford has existing plans for constructing and operating immobilization facilities for the wastes in Hanford tanks. DOE would not create new infrastructure for immobilizing Pu with HLW or cesium (Cs) at INEL, NTS, ORR, or Pantex.

- **Constructing and operating a Pu conversion facility[14] at either Hanford or SRS.** DOE would collocate the Pu conversion facility with the vitrification or ceramic immobilization facility discussed above. In subsequent, tiered NEPA reviews, DOE would analyze alternative locations at Hanford and SRS, for constructing new or potentially using modified existing buildings.

- **Constructing and operating a pit disassembly/conversion facility[15] at Hanford, INEL, Pantex, or SRS.** DOE would not add Pu to sites that do not currently have Pu in storage. Therefore, two sites analyzed in the PEIS, NTS and ORR, would not be considered further for Pu disposition activities. DOE would analyze alternative locations at Hanford, INEL, Pantex, and SRS for constructing new or potentially using modified existing buildings in subsequent tiered NEPA review. DOE would demonstrate the Advanced Recovery and Integrated Extraction System (ARIES) concept at LANL for pit disassembly/conversion beginning in fiscal year 1997.

- **Constructing and operating a domestic, Government-owned, MOX fuel fabrication facility at Hanford, INEL, Pantex, or SRS.** DOE would not add Pu to sites that do not currently have Pu in storage. Therefore, two sites analyzed in the PEIS, NTS and ORR, would not be considered further for Pu disposition activities. The MOX fuel fabrication facility would serve only the finite mission of fabricating MOX fuel using surplus Pu for the purpose of Pu disposition. DOE would analyze alternative locations at Hanford, INEL, Pantex, and SRS, for constructing new or potentially using modified existing buildings in subsequent tiered NEPA review.

[14] The Pu conversion facility would convert surplus non-pit Pu material (using a wet chemical process) into a metal or oxide form suitable for use at the next facility in the disposition process.

[15] The pit disassembly/conversion facility would disassemble, reshape, and convert surplus Pu pits (using a dry chemical process) into an unclassified metal or oxide form suitable for use at the next facility in the disposition process. In addition, some non-pit Pu material may also be processed in this facility.

Depending upon decisions in the ROD and pursuant to appropriate NEPA review(s), DOE would continue R&D and engage in further testing and demonstrations of Pu disposition technologies which may include: dissolution of small quantities of Pu in both glass and ceramic formulation; experiments with immobilization equipment and systems; fabrication of MOX fuel pellets for demonstrations of reactor irradiation at INEL; mechanical milling and mixing of Pu and feed forms; and testing of shipping and storage containers for certification, in addition to the testing and demonstrations previously described for the can-in-canister immobilization variant and the ARIES. These tests and demonstrations would slightly reduce the quantity of RFETS pit and non-pit materials to be stored at Pantex and SRS, respectively.

The storage and disposition actions proposed for various DOE sites by the Preferred Alternative are summarized in Table 1.6–1.

Table 1.6–1. Storage and Disposition Actions Proposed by the Preferred Alternative

Action	Hanford	NTS	INEL	Pantex	ORR	SRS	RFETS	LANL
Storage								
No Action	X[a]	X[b]	X[a]					X[a]
Upgrade				X[c]	X[d]	X[e]		
Phaseout							X	
Disposition[f]								
Pit Disassembly/Conversion	X		X	X		X		
MOX Fuel Fabrication	X		X	X		X		
Pu Conversion	X					X		
Immobilization	X					X		

[a] Pending subsequent tiered NEPA decisions for disposition of surplus Pu.
[b] NTS does not currently store either Pu or HEU.
[c] For storage of those pits currently at Pantex and pits from RFETS.
[d] For storage of HEU only.
[e] For storage of only those Pu materials currently at SRS and non-pit Pu materials from RFETS.
[f] "X" denotes potential sites for locating the disposition facilities pending subsequent tiered NEPA decisions. Only one of each facility is needed for accomplishing the disposition mission.

1.7 SCOPE OF THE PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

Public Scoping Process. During 1994, DOE conducted a phased scoping process to solicit comments on long-term storage and disposition of weapons-usable fissile materials. The initial phase of the scoping process consisted of a series of planning meetings attended by technical experts from DOE's National Laboratories, industry, and academia. These planning meetings helped introduce the objectives of the Fissile Materials Disposition Program to the public and to identify DOE and IWG's roles in implementing the President's *Nonproliferation and Export Control Policy.*

On May 4 and 5, 1994, DOE conducted the first public meeting in Washington, DC. Using the 1994 NAS study as a starting point, the public meeting served as a forum to solicit input on the scope of the Notice of Intent (NOI), which was published on June 21, 1994, in the *Federal Register* (59 FR 31985) to inform the public of the preparation of the Storage and Disposition PEIS.

During August, September, and October 1994, 12 workshops were held to solicit public comment on the scope of the program. Figure 1.7–1 shows the locations and dates of these public scoping workshops. Written comments on the scope of the Storage and Disposition PEIS were also requested from the public. The objective of the workshops was four-fold: comply with NEPA requirements; ensure that the PEIS addresses a range of

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MOX Fuel Fabrication	X		X	X		X		
Pu Conversion	X					X		
Immobilization	X					X		

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In addition to the 12 workshops, DOE conducted 2 other meetings in November and December 1994 to obtain public input on the NEPA review strategy and reasonable alternatives for disposition of surplus weapons-usable HEU and Pu. The meeting on November 10, 1994, in Oak Ridge, Tennessee, led to DOE's decision to proceed with a separate EIS to evaluate reasonable disposition alternatives for surplus HEU. A meeting on December 13 and 14, 1994, in Herndon, Virginia, provided preliminary feedback on Pu disposition alternatives from the scoping process and public input on additional concerns relative to the alternatives being considered.

Incorporating Input in the Screening Process. As part of the overall scoping process, a screening committee consisting of five DOE technical experts was formed to identify the reasonable alternatives to be evaluated in the Storage and Disposition PEIS. Using a screening evaluation process to compare potential alternatives against a set of screening criteria, the committee considered input from the general public and used technical reports and analyses from the national laboratories and industry to develop the final list of reasonable alternatives. The initial screening process and results were reviewed by the IWG and a senior technical review group of outside experts.

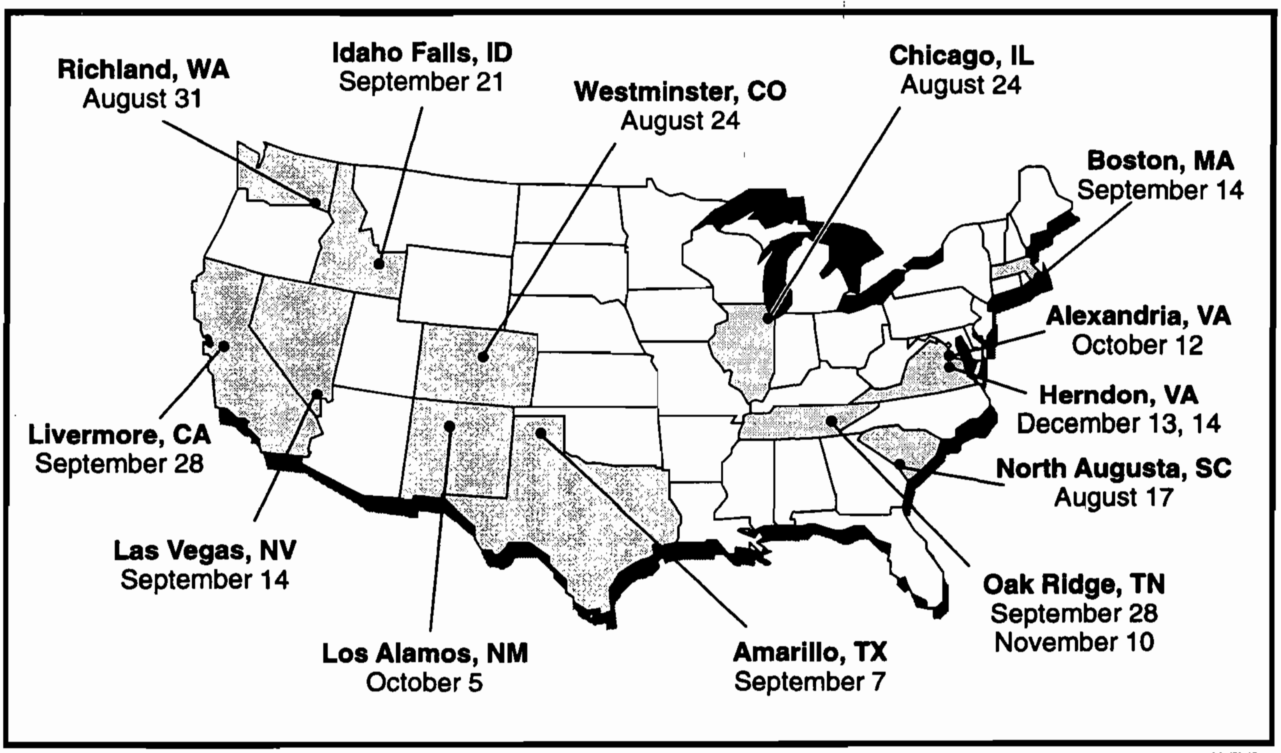

Figure 1.7–1. Public Scoping Workshop Locations, 1994.

The Department proposed criteria for screening reasonable Storage and Disposition PEIS alternatives and submitted them for public review and comment as part of the formal scoping process for the PEIS. During the scoping workshops, participants were given questionnaires to evaluate DOE's proposed screening criteria. The responses to these questionnaires, together with comments submitted by the public regarding the screening criteria, were reviewed by the screening committee. The input from the questionnaires resulted in several changes and clarifications of the criteria. The final criteria used for selecting alternatives are described in Chapter 2 of this PEIS.

Defining the Significant Issues. In the comment analysis process, written and oral public comments were reviewed and considered on their merits equally, regardless of the manner in which they were submitted. Each public comment was entered into a comment tracking system. A database was created with more than 3,000 individual records documented, and an analysis of similar comments was conducted to identify specific issues that the public felt DOE should address as part of the Storage and Disposition PEIS. The analysis of comments resulted in the identification of approximately 50 issues organized under the following 12 major issue categories:

- Overall scope of the proposed action and alternatives
- Storage alternatives
- Pu disposition
- HEU disposition
- Nonproliferation
- Surplus fissile materials declaration
- Spent Fuel Standard
- Environmental impacts
- Nonenvironmental impacts
- Relationship of the PEIS to other DOE actions
- Screening criteria
- Public participation

The resolution of many comments was described in the *Long-Term Storage and Disposition of Weapons-Usable Fissile Materials Programmatic Environmental Impact Statement Implementation Plan* (DOE/EIS-0229-IP, March 1995) for the Storage and Disposition PEIS. Issues regarding environmental impacts are addressed in this PEIS.

Organizing the Programmatic Environmental Impact Statement to Address Significant Issues. As mentioned in Section 1.3, DOE's proposed action involves evaluation of reasonable alternatives for long-term storage and disposition of weapons-usable Pu and HEU. These alternatives are as follows:

Storage:

- Storage Alternatives
  - Preferred Alternative (Combination)
  - Upgrade at Multiple Sites Alternative
  - Consolidation of Pu Alternative
  - Collocation of Pu and HEU Alternative
  - No Action Alternative
- Candidate Storage Sites

- Hanford
- NTS
- INEL
- Pantex
- ORR
- SRS

Environmental impacts of each long-term storage alternative and the No Action Alternative are analyzed for each of the six candidate storage sites to allow (1) the comparison of impacts by site for each alternative and (2) the comparison of impacts by alternative for each site. As a result, decisions can be made to select a single storage alternative for all sites or a combination of different alternatives for different sites.

Disposition:

- Preferred Alternative (Combination)
- Deep Borehole Category
  - Direct Disposition Alternative
  - Immobilized Disposition Alternative
- Immobilization Category
  - Vitrification Alternative
  - Ceramic Immobilization Alternative
  - Electrometallurgical Treatment Alternative
- Reactor Category
  - Existing LWR Alternative
  - Partially Completed LWR Alternative
  - Evolutionary LWR Alternative
  - CANDU Reactor Alternative
- No Disposition Action

Facilities under each alternative within the Immobilization and Deep Borehole Categories could be designed such that they could process all the surplus Pu over their operating lives. Each disposition alternative under the Reactor Category would consist of reactors that would use the MOX fuel produced from surplus; however, existing surplus Pu comes in various forms, and some of these forms may not be suitable for conversion to MOX fuel without specialized chemical processing.

[Text deleted.] In addition to the proposed storage and disposition alternatives, a No Action Alternative is analyzed. This alternative has two parts: (1) no change in current storage of Pu and HEU and (2) no disposition of surplus Pu. DOE may choose part one, part two, or both parts of this alternative. If only part one were chosen, no change in long-term storage would take place. Therefore, the current DOE storage sites would be used for continued storage of HEU and nonsurplus Pu (the No Action Alternative for these materials), while decisions would be made for surplus Pu disposition. If only part two were chosen, disposition of surplus Pu would not occur, and this material would remain in storage. Therefore, decisions on long-term storage would become the "No Disposition Action" for surplus Pu. If both parts were chosen, no Pu disposition and no change in current storage of Pu and HEU would occur. This case is analyzed in the Storage and Disposition PEIS as the baseline case for the No Action Alternative. Disposition of surplus HEU is addressed in the HEU EIS.

Each of these alternatives, along with the screening process that led to the selection of these alternatives, is described in detail in Chapter 2. Definitions of the environmental resources and issue areas, and descriptions of the affected environments at each site, are presented in Chapter 3. The general approach and specific methods for assessing environmental consequences, along with estimated results and potential cumulative impacts, are presented in Chapter 4. The information and environmental analyses provided in this PEIS, together with separate cost, schedule, technical, and policy analyses, are intended to address all significant issues raised during the scoping process.

Changes in Scope. The original NOI to prepare the Storage and Disposition PEIS included the disposition of surplus HEU, long-term storage and disposition of surplus U-233, and long-term storage and disposition of minor actinides.

In the course of the public scoping process, it was deemed more appropriate to analyze the impact of surplus HEU disposition in a separate EIS. The decision to analyze HEU separately from the Storage and Disposition PEIS was made for a number of reasons, including the following:

- The disposition of surplus HEU could use existing technologies and facilities in the United States, in contrast to the disposition of surplus Pu.
- The disposition of surplus HEU would involve different alternatives, timeframes, technologies, facilities, and personnel than those required for the disposition of surplus Pu.
- Decisions on surplus HEU disposition are independently justified; would not affect, trigger, or preclude other decisions that may be made regarding the disposition of surplus Pu; and would not depend on actions taken or decisions made pursuant to the Storage and Disposition PEIS.
- Disposition is the most rapid path for neutralizing the proliferation threat of surplus HEU, is consistent with the President's *Nonproliferation and Export Control Policy*, would demonstrate U.S. nonproliferation commitment to other nations, and is consistent with the course of action now underway in Russia to reduce Russian HEU stockpiles.

Accordingly, DOE concluded that surplus HEU disposition should be treated separately, and published a notice in the *Federal Register* (60 FR 17344) in April 1995 to inform the public of its conclusion. The HEU Draft EIS was issued for public review in October 1995 (60 FR 54867), the HEU Final EIS was issued in June 1996 (61 FR 33719), and the resulting ROD was published on August 5, 1996 (61 FR 40619).

The long-term storage and disposition of surplus U-233 were also included in the original scope of the Storage and Disposition PEIS. Existing surplus U-233 is stored at two DOE sites in small quantities. Results of preliminary studies indicate that the only reasonable alternative for U-233 is to blend it down and dispose of it as waste. However, in contrast to Pu and HEU, U-233 is a high-energy radiation source, must be remotely handled, and involves additional worker and public radiation health and safety concerns that would need to be accommodated. In addition, if the U-233 is to be disposed of as waste, the requirements for its waste form must be established for existing or planned waste repositories or disposal sites. Further research on waste form requirements and the feasibility of blending the U-233 to meet these requirements is needed to assess the final disposition of this material. Finally, because U-233 emits high-energy radiation, it is inherently more proliferation-resistent than Pu.

Since U-233 disposition is not ready for decision, DOE is not currently proposing to take action on the disposition of surplus U-233, which will continue to be stored at current locations. Upon identification of disposition requirements and verification of the feasibility of accommodations to meet these requirements, DOE may propose disposition of surplus U-233 and would conduct appropriate environmental analyses under NEPA at that time. Any such disposition of surplus U-233, if proposed, would involve different alternatives, wastes, personnel, worker safety concerns, technologies, and proliferation concerns than disposition of Pu. Any disposition of surplus U-233, if proposed, would be independent of surplus Pu disposition, would be independently justified, would not trigger or affect Pu disposition, and could proceed regardless of any subsequent or prior Pu disposition actions.

The long-term storage and disposition of minor actinides, radioisotopes having atomic numbers of 95 and above, were included in the original scope of the Storage and Disposition PEIS. An assessment of these materials showed that they exist in small quantities, are in active program use, or are planned to be declared wastes. Consequently, there is no need to include minor actinides in the scope of this PEIS.

1.8 SUMMARY OF MAJOR ISSUES IDENTIFIED DURING THE COMMENT PERIOD AND CHANGES TO THE DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

1.8.1 Issues Identified and Resolved

The Department initially issued the Storage and Disposition PEIS as a draft for public comment for the period from March 8 through May 7, 1996 (61 FR 9443). In response to public requests, DOE extended the comment period deadline to June 7, 1996 (61 FR 22038). Public meetings on the Draft PEIS were held in March and April 1996 at the following locations:

Denver, CO	March 26, 1996
Las Vegas, NV	March 28–29, 1996
Oak Ridge, TN	April 2, 1996
Richland, WA	April 11, 1996
Idaho Falls, ID	April 15, 1996
Washington, DC	April 17–18, 1996
Amarillo, TX	April 22–23, 1996
North Augusta, SC	April 30, 1996

During the 92-day public comment period on the Storage and Disposition Draft PEIS, DOE received comments on the document by mail, fax, telephone recording, electronic mail, and orally at the public meetings. Altogether, DOE received approximately 8,700 written and recorded comments from individuals and organizations. All comments are presented in Volume IV of the Storage and Disposition Final PEIS, the *Comment Response Document* (CRD).

Approximately 80 percent of the comments received consisted of mail-in letter and postcard campaigns which expressed either support of or opposition to the use of various sites or alternatives. Many commentors encouraged DOE and the United States to become the world leader in the safe, secure, and timely disposition of

Pu, and favored worldwide nonproliferation efforts for surplus Pu. The following highlights some of the recurring comments, DOE's response, and the PEIS revisions in response to these comments.

A number of commentors expressed the opinion that the surplus Pu should remain in present locations for future energy or weapons use, or until new technologies are available for disposition. In response to these concerns, DOE expanded the discussion on the need for the proposed Pu disposition action in the PEIS. Disposition is necessary to implement the President's *Nonproliferation and Export Control Policy* in a safe, reliable, cost-effective, and timely manner.

Some commentors also stated that DOE should consider additional disposition alternatives, including the use of FFTF, deep burn reactors, and mononitride reactors. The use of advanced reactors such as deep burn reactors and mononitride reactors was considered but eliminated due to the technical immaturity, attendant costs, and lengthy development and demonstration efforts required to bring the technologies to a viable, practical status and enable disposition options to be initiated with certainty. The FFTF would be considered for Pu disposition if first selected for tritium production. The FFTF is not a reasonable, stand alone alternative because it is in a standby status awaiting shutdown and because it could not satisfy the criterion of completing the disposition mission within 25 years. A discussion of FFTF for this purpose is included in Appendix N. In all, 37 different alternative options were considered by DOE for disposition of Pu. DOE has made revisions to the Summary and Chapter 2 of the PEIS to clarify how the screening process was used for selection of reasonable alternatives.

Commentors noted that transportation of fissile materials is one of their major concerns with the Program. The ground transportation between sites, in the event a consolidation alternative was selected, could increase the potential for traffic accidents. International transportation for specific border crossings for the shipment of MOX fuel to Canada for the CANDU Reactor Alternative was also identified as a concern. DOE acknowledges the public's concern, and in response, the transportation analysis in Section 4.4 and Appendix G of the Draft PEIS was expanded. The revisions address security measures for land and sea transport, emergency preparedness, and clarify the results of analyses performed.

One frequently recurring comment presented by the public relates to the technical, cost, schedule, and nonproliferation analyses to support DOE's ROD. Many of the commentors suggested that DOE should make information available for public review. Since issuance of the Draft PEIS, DOE has prepared both the *Technical Summary Report for Long-Term Storage of Weapons-Usable Fissile Materials* (DOE/MD-0004 Rev. 1) and the *Technical Summary Report for Surplus Weapons-Usable Plutonium Disposition* (DOE/MD-0003 Rev. 1). These two reports summarize representative technical, cost, and schedule data for the reasonable alternatives being considered for long-term storage and surplus Pu disposition, respectively. In July and August 1996, these documents were initially distributed for public review and comment. After taking the public's comments into consideration, DOE revised and re-issued both reports in November and December 1996. In October 1996, DOE issued the *Draft Nonproliferation and Arms Control Assessment of Weapons-Usable Fissile Material Storage and Plutonium Disposition Alternatives*, which analyzes the nonproliferation and arms reduction implications of the alternatives addressed in the PEIS for Pu and HEU storage and the disposition of surplus Pu. From October through early November 1996, the public was asked to review and comment on the draft nonproliferation document; this process included a series of 10 public meetings held nationwide. Public comments received are being taken into consideration in revising the report, which is scheduled for re-issue in late 1996. This report, in conjunction with the Final PEIS, the technical summary reports previously described, and public input, will form the basis for DOE's decisions, which will be discussed in a ROD to be issued no sooner than 30 days after publication of the Environmental Protection Agency's Notice of Availability of the Storage and Disposition Final PEIS.

Commentors also stated that the U.S. Nonproliferation Policy does not encourage the civil use of Pu or Pu processing for either nuclear power or nuclear explosive purposes. The commentors requested that the PEIS address the possibility that the MOX option would have an adverse effect on U.S. nonproliferation policy by encouraging its use in civil nuclear power programs and by encouraging Pu reprocessing and recycling. DOE acknowledges the public concern for nonproliferation. As discussed in the PEIS, the reactor option would utilize a once-through fuel cycle. Spent fuel from disposition would be disposed of with other commercial reactor spent fuel. This is consistent with U.S. policy since no Pu in the spent fuel would be recycled. Revisions to Chapter 1 of the PEIS were made to expand and clarify this issue.

Commentors indicated that the isotopic composition of the residual Pu in the final waste forms is an inappropriate criterion by which to assess proliferation risks because it perpetuates a myth that reactor-grade Pu cannot be used to make workable weapons. In the opinion of these commentors, isotopic degradation does not constitute a compelling argument in favor of the MOX option. DOE acknowledges that, although it may be possible to make a nuclear weapon from spent commercial reactor fuel, this can only be done with extreme difficulty by individuals with a great deal of experience in handling and processing nuclear materials. DOE believes that the disposition of weapons Pu through the use of MOX fuel in reactors would meet the Spent Fuel Standard in creating a radiological barrier that makes the Pu as difficult to retrieve and reuse in weapons as Pu in spent commercial fuel. The use of this technology would allow for the Pu to be disposed in a geologic repository pursuant to the *Nuclear Waste Policy Act*,[16] the same as for spent commercial fuel. Revisions to Chapter 1 of the PEIS were made to clarify this issue.

1.8.2 CHANGES MADE TO THE DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

This section identifies changes made since the issuance of the Draft PEIS. The Final PEIS includes the Preferred Alternative, which is a combination of other alternatives and is described in Section 1.6. Other changes, after considering public comments, are described below.

Appendix N, which in the Draft PEIS summarized the operational aspects of the multipurpose reactor, has been revised for the Final PEIS to provide information on the costs and benefits of conducting separate tritium production and Pu disposition missions versus the costs and benefits of carrying out one multipurpose mission. Included in Appendix N is a cost comparison of using new Advanced LWRs or Modular Helium Reactors (MHR), and a discussion of issues regarding the use of the FFTF (a liquid metal reactor at Hanford) for tritium production and Pu disposition.

Appendices O, P, Q, and R were added to the Final PEIS to help clarify alternative issues as they relate to the Preferred Alternative. Appendix O describes two can-in-canister technology concepts at SRS, which are variants of the Vitrification and Ceramic Immobilization Disposition Alternatives described in Chapter 2. This information was added based on public interest in these concepts during the Draft PEIS comment period, and also because of DOE's reconsideration of this technology as being a viable approach for Pu disposition through immobilization.

Appendix P provides a description of using the Manzano Weapons Storage Area (WSA) near Albuquerque, NM to store Pu pits. This appendix was added because DOE's Preferred Alternative separates the storage of pits from non-pit materials, in which case Manzano WSA no longer appears unreasonable under the Preferred Alternative for pit storage. However, since DOE's preferred site for interim storage of pits is Pantex (as described in the Pantex EIS) and since the majority of pits are already located in storage at Pantex, the Preferred Alternative proposes the long-term storage of Pu pits at Pantex. Weapons assembly/disassembly would continue at Pantex in any case. Construction of a new storage facility at Manzano would create needless expense and transportation risk.

Appendix Q describes the operations and human (radiological) health impacts associated with Pu pits being transferred from RFETS to Pantex, repackaged in Zone 12 South, and placed in storage in Zone 4 West at Pantex, as part of the Preferred Alternative for storage. The information presented in this appendix is based on the Pantex EIS analysis of storing the Pu pits already at Pantex.

[16] Also referred in the PEIS as a geologic, permanent, or HLW repository.

Appendix R discusses aircraft crash and radioactive release probabilities for proposed storage and disposition facilities at Pantex.

Section 1.2 of the Final PEIS has been revised to reflect the cooperative effort between the United States and Russia to study different options for managing excess Pu (including secure storage, conversion of Pu weapons components to other forms, and stabilization of unstable forms of Pu), and options for disposition of excess Pu (deep borehole, immobilization, and reactors). The results of this study have been documented in the *Joint United States/Russian Plutonium Disposition Study* report, completed in September 1996. This study and the options considered will provide decisionmakers from both countries with a set of jointly evaluated alternatives for Pu disposition and help build further trust and cooperation in the area of fissile material disposition.

Chapter 2
Weapons-Usable Fissile Materials Long-Term Storage and Disposition Alternatives

2.1 DEVELOPMENT OF ALTERNATIVES

Alternatives analyzed in this PEIS were determined through a screening evaluation process in which a comprehensive set of screening criteria were used. From this process, reasonable alternatives for the following were identified:

- The strategy for long-term storage of weapons-usable Pu and HEU, including nonsurplus Pu and HEU, and surplus Pu and HEU pending disposition
- The strategy and technology for disposition of surplus weapons-usable Pu

In addition, a list of candidate sites for long-term storage of weapons-usable Pu and HEU was developed based on site-selection criteria established previously. The site selection process is described in Section 2.1.3. These reasonable alternatives and candidate sites are analyzed in this PEIS as part of the input for DOE's decisionmaking on the storage and disposition of weapons-usable fissile materials.

2.1.1 SCREENING CRITERIA

To determine reasonable alternatives for evaluation in this PEIS, DOE developed, for both long-term storage and disposition, screening criteria based on the policy objectives articulated in the President's *Nonproliferation and Export Control Policy* of September 1993 and the January 1994 *Joint Statement by the President of the Russian Federation and the President of the United States of America on Nonproliferation of Weapons of Mass Destruction and the Means of Their Delivery* (see Appendix A), as well as the analytical framework established by NAS in its 1994 report, *Management and Disposition of Excess Weapons Plutonium* study. Based on input from the public during the scoping process, the screening criteria were expanded and used for selecting reasonable alternatives. Descriptions of the screening criteria used for long-term storage and disposition alternatives are given in Sections 2.1.3 and 2.1.4, respectively.

2.1.2 SCREENING EVALUATION PROCESS

The screening evaluation was conducted by a committee of five DOE technical experts, DOE officials assisted by advisors from the National Laboratories, and other support staff. Based on a review of the NAS report, prior DOE-sponsored work on HLW disposal, and input from the public obtained during the scoping process, the screening committee identified an extensive set of options and developed potential disqualifiers for both long-term storage and disposition options. Each option represented a storage or disposition strategy that might be implemented in a systematic, cradle-to-grave manner. There were 5 long-term storage options, 37 Pu disposition options, 9 HEU disposition options, and 8 U-233 disposition options. As previously identified in Chapter 1, the disposition of surplus HEU and disposition of U-233 are not within the scope of this Storage and Disposition PEIS; disposition of surplus HEU is addressed in the HEU Final EIS and U-233 disposition will be addressed at the time it is proposed by DOE and found to be ready for decision.

The screening committee evaluated each option against potential disqualifiers to determine if any options had a "fatal flaw" in one or more of the screening criteria. For example, inability to meet the Stored Weapons Standard or the Spent Fuel Standard was considered a fatal flaw that resulted in the disqualification of an option. Options that survived this process were then ranked. Each option was rated high, medium, or low against each screening criterion, relative to other options. This ranking process eliminated options that were rated low for multiple criteria or were clearly dominated by similar, more attractive options in the same category. Options that survived the ranking process emerged as reasonable alternatives for detailed evaluation in the Storage and Disposition PEIS. Details of the screening evaluation process can be found in the *Summary Report of the Screening Process* (DOE/MD-0002). After considering public comment on the Draft PEIS, as well as other public comments and internal DOE review following the Draft PEIS, DOE has for some of the disposition alternatives clarified and expanded explanations of the screening rationale and has added DoD's Manzano WSA Facility as a storage facility under consideration. A description of alternatives considered but eliminated for further analysis, along with reasons for elimination, is given in Section 2.1.3 for long-term storage and Section 2.1.4 for Pu disposition.

2.1.3 REASONABLE ALTERNATIVES FOR LONG-TERM STORAGE OF WEAPONS-USABLE FISSILE MATERIALS

Screening Criteria for Long-Term Storage Options

Resistance to Theft and Diversion by Unauthorized Parties. The site and facility must be capable of providing comprehensive protection and control of weapons-usable fissile materials (that is, meet the Stored Weapons Standard).

Technical Viability. There should be a high degree of confidence that the facility and site infrastructure can provide storage of nuclear components and materials for up to 50 years.

Environment, Safety and Health (ES&H) Compliance. High standards of public and worker health and safety and environmental protection must be met, and significant additional ES&H burdens should not be created.

Cost-Effectiveness. Long-term storage should be accomplished in a cost-effective manner and should be compatible with reasonable disposition alternatives.

Timeliness. Long-term storage should be implemented in a timely manner.

Fosters Progress and Cooperation With Russia and Other Countries. A facility must accommodate international inspections for surplus material in unclassified forms and must establish appropriate standards for storage and protection of international nuclear material inventories.

Public and Institutional Acceptance. An alternative should be able to muster a broad and sustainable consensus on the manner in which long-term storage is accomplished.

Results of the Screening Process: Reasonable Alternatives for Long-Term Storage

Options that were not disqualified or eliminated through the use of the screening criteria emerged from the screening process as reasonable options for further evaluation. As a result of the screening process, two options were identified as reasonable:

- Upgrade of storage facilities to make them suitable for long-term storage (upgrade existing storage capability at more than one site)
- Consolidation of the weapons-usable fissile materials at DOE sites (consolidate or collocate storage at one or two DOE sites)

Both options assumed that all nonsurplus HEU and surplus HEU pending disposition were located at ORR before initiating any action under this PEIS. The scope of the first option, upgrade existing storage capability (referred to in the PEIS as Upgrade at Multiple Sites Alternative or Upgrade Alternative), has been expanded to include the possibility of upgrading through new construction where existing facilities cannot be economically modified to meet requirements and to account for the relocation of RFETS and/or LANL Pu to one or more Pu storage sites. The second option, consolidate storage at DOE sites, has been modified to separately address two alternative approaches: the Consolidation of Pu Alternative, and the Collocation of Pu and HEU Alternative. For each alternative (Upgrade at Multiple Sites Alternative, Consolidation of Pu Alternative, and the Collocation of Pu and HEU Alternative), a subalternative has also been added that would exclude the strategic reserve and weapons R&D material covered by the Stockpile Stewardship and Management PEIS. Finally, a Preferred Alternative was developed, representing a combination of alternatives. The PEIS alternatives are further described.

Upgrade at Multiple Sites Alternative: Modify Existing *and/or* Construct New Facilities at More Than One Site for Continued Storage of Plutonium and Highly Enriched Uranium; Relocate Rocky Flats Environmental Technology Site and Los Alamos National Laboratory Plutonium to Another Plutonium Storage Site. Under this alternative, DOE would modify certain existing facilities and/or build new facilities, depending on individual site requirements for meeting updated DOE standards for nuclear material storage facilities. The facilities would be designed to operate for up to 50 years. Pu material currently stored at Hanford, INEL, Pantex, and SRS would remain at those sites. Pu currently in storage at RFETS and LANL would be moved to a single long-term storage site or distributed for long-term storage at more than one site. HEU material stored at ORR would remain at that site in modified facilities.

Consolidation of Plutonium Alternative: Construct New Facility *or* Construct New and Modify Existing Facilities at One Site for all Plutonium Materials; Maintain (and Modify as Necessary) Existing Highly Enriched Uranium Facilities at Oak Ridge Reservation. Under this alternative, a new consolidated Pu storage facility would be constructed alone or with modified existing facilities to store current and future DOE weapons-usable Pu inventories. Pu would be removed from existing storage facilities at Hanford, INEL, Pantex, SRS, RFETS, and LANL and transported to the consolidated storage facility. The facility would be designed to provide safe, secure, long-term storage of both nonsurplus Pu and surplus Pu (pending disposition) for up to 50 years. HEU material stored at ORR would remain at that site. DOE would maintain and, as necessary, modify and upgrade the ORR facilities to ensure continued safe, secure storage.

Collocation of Plutonium and Highly Enriched Uranium Alternative: Construct New Facility *or* Construct New and Modify or Maintain Existing Facilities at One Site for all Plutonium and Highly Enriched Uranium Materials. Under this alternative, a new consolidated Pu storage facility would be collocated with new or existing HEU facilities to store current and future DOE weapons-usable fissile material inventories. The facilities would be responsible for storing Pu as well as HEU. Pu would be moved from existing storage facilities at Hanford, INEL, Pantex, SRS, RFETS, and LANL. HEU would either stay at ORR, should ORR be selected, or be moved to the collocated storage facility. The facility would be designed to provide safe, secure, long-term storage for up to 50 years.

Preferred Alternative. Under the Preferred Alternative, existing facilities would be upgraded at Pantex, ORR,[1] and SRS. RFETS Pu pits would be relocated to Pantex, and RFETS surplus non-pit Pu materials would be relocated to SRS. Current storage would continue (No Action) at Hanford, INEL, and LANL for surplus Pu, pending disposition. Strategic Reserve pits would be stored at Pantex in accordance with the Preferred Alternative in the Stockpile Stewardship and Management PEIS. No Action would be taken at NTS; Pu storage would not be added to NTS, consistent with the site's current mission.

Figure 2.1.3–1 depicts the conceptual structure of the long-term storage alternatives and the Preferred Alternative for storage analyzed in this PEIS. Under each long-term storage alternative and the No Action

[1] DOE may subsequently propose to construct new HEU storage facilities at ORR; any such proposal would be assessed in subsequent site-specific NEPA documentation.

Alternative, Figure 2.1.3–1 describes the action that would be taken at the various candidate sites and locations for these materials.[2] For the No Action Alternative and upgrade, consolidation and collocation long-term storage alternatives, this PEIS analyzes the impact of storing all weapons-usable fissile materials. Under these alternatives, this PEIS also analyzes the impacts of storing weapons-usable fissile materials excluding those covered under the Stockpile Stewardship and Management PEIS (strategic reserves and some weapons R&D materials). [Text deleted.]

Candidate Sites for Long-Term Storage Alternatives

Six locations (Hanford, NTS, INEL, Pantex, ORR, and SRS) are being considered as candidate sites for the long-term storage of weapons-usable fissile materials. Each site is being considered for the location of upgraded, consolidated, or collocated storage facilities.

Site Screening Process

Concurrent with the publication of the NOI to prepare a PEIS for Reconfiguration of the Nuclear Weapons Complex in the *Federal Register* (56 FR 5590) on February 11, 1991, a *Notice of Availability of an Invitation for Site Proposals for the Nuclear Weapons Complex Reconfiguration Site* was also published (56 FR 5595). The invitation solicited proposals for consideration of non-DOE sites and listed five DOE sites that met the initial screening criteria (Hanford, INEL, Pantex, ORR, and SRS). No additional locations were identified as a result of this invitation.

The five initial sites were evaluated against the following siting criteria: (1) density and distribution of population, (2) ES&H, (3) socioeconomics, (4) site availability, (5) transportation, and (6) site flexibility. All sites were found by the Site Evaluation Panel to be fully qualified.

There have been significant changes in the world since publication of the *Nuclear Weapons Complex Reconfiguration Study* in January 1991, especially with regard to projected future requirements of the United States' nuclear weapons stockpile. As a result, the study no longer provides a suitable framework for determining the appropriate configuration of the future Nuclear Weapons Complex. Therefore, DOE decided to separate the Reconfiguration PEIS into two PEISs: a TSR PEIS and a Stockpile Stewardship and Management PEIS.

A Revised NOI to prepare a Reconfiguration PEIS was published in the *Federal Register* (58 FR 39528) on July 23, 1993. In this notice, DOE eliminated Hanford from further consideration as a candidate site, because all nuclear weapons production functions at that location had been terminated and the site was dedicated to environmental and waste management activities. NTS was evaluated using the siting criteria described above and was determined to be a reasonable site alternative for new tritium supply and recycling facilities. The resulting five sites—NTS, INEL, Pantex, ORR, and SRS—were evaluated in the TSR PEIS.

The long-term storage mission is a portion of the proposed action considered under the original reconfiguration proposal. Thus, sites meeting criteria for reconfiguration are considered reasonable for the long-term storage mission. Since the five TSR sites meet these criteria, they are being considered for long-term storage of weapons-usable fissile materials. In addition, Hanford is considered a reasonable site for the following reasons:

- It satisfies the original reconfiguration criteria
- Long-term storage is consistent with its current mission

[2] As of September 1994, LLNL stored 0.3 t (0.3 tons) of Pu, which are primarily R&D and operational feedstock materials not surplus to government needs. Adequate storage facilities for this material currently exist at LLNL; consequently, none of the Pu stored at LLNL falls within the scope of this Storage and Disposition PEIS.

- It has the infrastructure to support a long-term storage mission

The resulting sites—Hanford, NTS, INEL, Pantex, ORR, and SRS—are analyzed in the PEIS.

Long-Term Storage Alternatives Considered But Eliminated from Further Analysis

As a result of the screening process, two long-term storage options were eliminated: the utilization of existing facilities at non-DOE domestic sites for storage of non-pit Pu forms, and the utilization of non-domestic sites. The utilization of existing facilities at non-DOE sites for long-term storage as an option was rated but eliminated from further consideration. The Pantex EIS analyzes DoD's Manzano WSA near Albuquerque, NM, as a candidate non-DOE domestic site for temporary storage of Pu pits (58 FR 39528). [Text deleted.]

As in the case of temporary pit storage, the materials to be placed in long-term storage include Pu pits. However, they also include oxides and other dispersible material forms that may require treatment and repackaging not needed for pits. There are ES&H concerns associated with locating these operations in proximity to the metropolitan Albuquerque area. Furthermore, there is insufficient land area available to construct the necessary direct support facilities needed for analysis, repackaging, accounting, and waste management. Therefore, the Manzano WSA was considered in the Draft PEIS but eliminated as a reasonable alternative primarily because Manzano WSA could not accommodate storage of both pit and non-pit materials.

Since the issuance of the Draft PEIS, DOE has developed a Preferred Alternative for storage that would separate storage of most Pu pits from storage of non-pit Pu material. Specifically, the Preferred Alternative would store Pu pits from Pantex and RFETS at Pantex, and would store non-pit Pu at SRS, Hanford, and INEL. Since DOE's Preferred Alternative would separately locate storage of pits and non-pit Pu from RFETS, the option to store pits at Manzano WSA no longer appears unreasonable. Therefore, DOE has added Appendix P to the Final PEIS, which discusses potential storage of Pantex and RFETS pits at Manzano WSA.

For a number of reasons, the Preferred Alternative would store the pits from Pantex and RFETS at Pantex, rather than Manzano WSA. Pantex is the proposed site for interim storage of pits under the Preferred Alternative in the Pantex EIS.[3] The majority of the pits that require storage are surplus to U.S. defense needs and are already located at Pantex. The number of pits that would be relocated from RFETS would be small by comparison. Since the majority of pits are already in storage at Pantex, it would be prudent for DOE to consolidate all pits there for storage. Assembly and disassembly operations would continue at Pantex even if pit storage did not occur there. Selecting Manzano WSA would require DOE to create another site where Pu would be located with the risk of contamination and the associated costs for site infrastructure and security. In addition, other missions that could be added to Pantex (for example, pit disassembly/conversion or MOX fuel fabrication) could not be added to Manzano.

Storage at Manzano WSA would involve the transportation risk of moving these materials from Pantex to Manzano WSA. Furthermore, two shipment campaigns would be required for disposition for most of the pits (those already at Pantex) if Manzano WSA were chosen, whereas only one shipment campaign of those same pits would be required if the pits were stored at Pantex. For the Manzano case, pits at Pantex would require relocation to Manzano and then a second shipment campaign to a disposition site. Leaving the pits in storage at Pantex would result in only one shipment campaign from Pantex to the disposition site.[4]

The utilization of non-domestic sites for long-term storage was proposed, but was eliminated from further consideration because it was not able to address all of the long-term storage requirements. These requirements

[3] The disposition of these surplus pits would begin within the next 10 years and would be completed within the next 25 years. The time period required for the storage of the pits is therefore close to that considered in the Pantex EIS for pit storage and the reasons for not using Manzano WSA are the same.

[4] Two shipment campaigns of pits would be required for those pits currently stored at RFETS for both Pantex and Manzano.

include the storage of the materials set aside as strategic reserve for defense purposes, which are not appropriate to locate outside the United States. This option was disqualified in the screening process for non-strategic reserve material as well, because the risk of theft or diversion by unauthorized parties would be greater than those involved in the utilization of domestic sites. Safeguard and security of nuclear materials are also enhanced by the domestic law enforcement infrastructure, which would not be easily coordinated outside the United States. Figure 2.1.3–2 shows the long-term storage options that were considered and rated based on the seven screening criteria and the principal reasons for disqualification or elimination. The Preferred Alternative for storage at each DOE site was selected from among these storage options.

STORAGE OPTIONS

- **NO ACTION** → **Baseline**
- **UPGRADE EXISTING INTERIM STORAGE FACILITIES** → **Reasonable**
- **CONSOLIDATE STORAGE AT DOE SITES** → **Reasonable**
- **UTILIZE FACILITIES AT NON-DOE DOMESTIC SITES** → **Eliminated (Cost-Effectiveness, ES&H)**
- **UTILIZE NON-DOMESTIC SITES** → **Disqualified (Higher Safeguard and Security Risks)**

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Figure 2.1.3–2. Results of the Screening Process—Long-Term Storage Options.

2.1.4 REASONABLE ALTERNATIVES FOR THE DISPOSITION OF SURPLUS PLUTONIUM

Screening Criteria for Disposition Options

Resistance to Theft and Diversion by Unauthorized Parties. Each step in the disposition process must be capable of providing for comprehensive protection and control of weapons-usable fissile materials.

Resistance to Retrieval, Extraction, and Reuse by Host Nation. The surplus material must be made highly resistant to potential use in weapons to reduce reliance on institutional controls and demonstrate that the arms reductions will not be easily reversed.

Technical Viability. There should be a high degree of confidence that the alternative will be technically successful.

Environmental, Safety and Health Compliance. High standards of public and worker health and safety, and environmental protection must be met, and significant additional ES&H burdens should not be created.

Cost-Effectiveness. Disposition should be accomplished in a cost-effective manner and be compatible with reasonable long-term storage alternatives.

Timeliness. There is an urgent need to begin Pu disposition and to minimize the time period that surplus fissile materials remain in weapons-usable form.

Fosters Progress and Cooperation With Russia and Other Countries. The alternative must establish appropriate standards for the disposition of surplus weapons-usable fissile material inventories and support negotiations for bilateral or multilateral reductions in these materials, and each step in the disposition process must allow international inspections.

Public and Institutional Acceptance. An alternative should be able to muster a broad and sustainable consensus on the manner in which disposition is accomplished.

Additional Benefits. The ability to leverage government investments for disposition of surplus materials to contribute to other national or international initiatives should be considered.

Results of the Screening Process: Reasonable Alternatives for Surplus Plutonium Disposition

As a result of the screening process for surplus Pu disposition, three alternative categories consisting of nine alternatives are considered reasonable. The alternative categories for further evaluation are the deep borehole category, the immobilization category, and the reactor category.

Deep Borehole Category. Within this category, surplus weapons-usable Pu would be emplaced in deep boreholes drilled several kilometers below the water table into ancient, geologically stable rock formations. The deep boreholes would be sealed to isolate the Pu from the environment.

Two Deep Borehole Alternatives were analyzed for this PEIS:

- Direct Disposition Alternative—direct emplacement of canisters containing Pu forms that have not been immobilized

- Immobilized Disposition Alternative—Pu immobilized in ceramic pellets (without the addition of high-energy, gamma-emitting radionuclides) would be emplaced in a borehole as part of a grout-pellet mixture

In the first borehole alternative, surplus weapons-usable Pu would be encapsulated directly in suitable canisters without any immobilization processing of Pu material and the canisters would be placed in a deep borehole. The deep borehole would then be plugged after completion of the emplacement. In the second deep borehole alternative, surplus weapons-usable Pu would be converted to an immobilized ceramic form. The immobilized Pu form then would be directly emplaced in a deep borehole without encapsulation in canisters, and the deep borehole would be plugged after completion of the emplacement. Under both alternatives, emplacement in a deep borehole would provide a geologic barrier to proliferation and Pu could not be recovered by the host nation undetected. Therefore, the Pu would not need to be mixed with HLW or other radioactive materials to provide a radiation barrier to recovery.

Immobilization Category. Within this category, surplus Pu would be immobilized in an acceptable matrix to create a chemically stable form for disposal. The immobilized material would be placed in lag storage prior to transfer to a repository constructed pursuant to the *Nuclear Waste Policy Act* (NWPA), as amended (see discussion in Section 2.4). The immobilized Pu would contain HLW or a radioactive isotope to create a radiation field that enhances proliferation resistance to meet the Spent Fuel Standard.

Three Immobilization Alternatives were included in this PEIS:

- **Vitrification Alternative.** This alternative would consist of building a new facility or modifying existing facilities to produce a glass waste form that embeds Pu and radioisotopes within the glass form. This PEIS analyzes the impacts associated with building and operating a new facility at any of six DOE sites (Hanford, NTS, INEL, Pantex, ORR, and SRS). As an example of a technology variant at existing facilities, Appendix O of this PEIS describes the can-in-canister variant at the DWPF at SRS.

- **Ceramic Immobilization Alternative.** This alternative would consist of building a new facility or modifying existing facilities to produce a ceramic waste form that embeds Pu and radioisotopes within the ceramic form. This PEIS analyzes the impacts associated with building a new facility at any of six DOE sites (Hanford, NTS, INEL, Pantex, ORR, and SRS). As an example of a technology variant at existing facilities (with appropriate modifications), Appendix O of this PEIS describes the can-in-canister variant at the DWPF at SRS.

- **Electrometallurgical Treatment Alternative.** This alternative would utilize electrometallurgical treatment to produce a glass-bonded zeolite (GBZ) waste form that embeds Pu and radioisotopes within the GBZ form. Although this alternative could be conducted at other sites, the Argonne National Laboratory-West (ANL-W) site at INEL was used as an example site for evaluating potential environmental effects.

In all three alternatives, surplus weapons-usable Pu would be converted to an immobilized form (glass, ceramic, or GBZ). A radiation barrier for the immobilized surplus Pu would be required for nonproliferation purposes; the radioisotopes available to produce the barrier include radioactive Cs-137 (in storage at Hanford as cesium-chloride [CsCl] capsules in shippable form) or HLW (which would only be used if an immobilization facility were located at a site with quantities of this material). HLW would not be shipped between sites, thus avoiding additional risk in transportation.[5]

Reactor Category. Under this category, surplus Pu would be converted to MOX fuel for use in domestic or Canadian reactors. Using the MOX fuel would consume a portion of the Pu content of the fuel while embedding the rest in highly radioactive spent fuel similar to that now produced by uranium-fueled commercial power reactors. The resultant spent fuel then would be stored pending disposal in accordance with the applicable spent fuel program (U.S. or Canadian).

Analyses were conducted in this PEIS on four separate MOX fuel alternatives:

- Existing LWR Alternative—utilizing existing U.S. commercial reactors that would use MOX fuel instead of traditional LEU fuel

- Partially Completed LWR Alternative—completing construction of U.S. commercial reactors that are presently maintained in an extended interim state and utilize MOX fuel in these reactors

- Evolutionary LWR Alternative—building new reactors in the United States to use MOX fuel

- CANDU Reactor Alternative—utilizing existing Canadian reactors that would use MOX fuel instead of traditional natural uranium fuel

Because the United States does not have a MOX fuel fabrication facility or capability, a dedicated facility would likely have to be constructed or an existing facility be modified at a U.S. Government or existing commercial fuel fabricator's site. In the event MOX fuel is needed before a domestic fuel fabrication plant is available, existing facilities in Europe could be used on a short-term basis to provide initial lead test assemblies and other MOX fuel.

Preferred Alternative for Pu Disposition: A combination of Reactor and Immobilization Alternatives. The Preferred Alternative calls for (1) immobilizing at least those Pu materials not readily suitable for MOX fuel using vitrification or ceramic immobilization and (2) converting pure Pu metal, including pits and oxides into MOX fuel for use in existing reactors. Use of Canadian CANDU reactors would be retained in the event a multilateral agreement is made among Russia, Canada, and the United States to implement this.

The deployment of two disposition technologies would provide increased flexibility and assurance of mission accomplishment should technical problems develop with one technology as well as greater flexibility to deal

[5] Under the Immobilization Alternatives, DOE would not use CsCl or HLW that is a RCRA waste unless immobilization constituted sufficient RCRA treatment, or unless the CsCl or HLW first underwent RCRA treatment before immobilization with the surplus Pu.

with a wide range of Pu forms. The deployment of two technologies would signal a strong U.S. commitment to reducing the stockpiles of Pu and encourage Russia to reduce its stockpiles. The two disposition technologies that would allow an early start of Pu disposition have been determined to be the reactor and immobilization alternatives. The Preferred Alternative is a combination of reactor and immobilization alternatives.

Figure 2.1.4–1 depicts the alternative strategies and technologies for disposition of surplus Pu including the Preferred Alternative for disposition and how the material flows from the front-end process to the disposition categories.

Front-End Processes Common to Surplus Plutonium Disposition Alternatives

For the disposition of surplus Pu, a conversion process would be required to transform the various Pu forms into one suitable for further use in each of the disposition alternatives. Either pit disassembly/conversion (Section 2.4.1) or a Pu conversion process would be used (Section 2.4.2), depending on the current form of the surplus material.

Sites for the Analysis of Plutonium Disposition Alternatives

Six DOE sites and other generic and specific sites were used for assessing environmental impacts of various disposition techniques and strategies. The sites include Hanford, NTS, INEL, Pantex, ORR, and SRS. Additionally, some disposition facilities (specifically those involving the deep borehole complex, MOX fuel fabrication at a commercial facility [combination of five reactor fuel fabrication sites], and use of existing LWRs [combination of 12 existing LWRs at five sites]) have no representative sites, and so do not lend themselves to site-specific analysis at this time. Therefore, as explained more fully in Section 3.10 for the deep borehole, Section 3.11 for the MOX fuel fabrication site, and Section 3.12 for the existing LWR site, generic site characteristics have been developed for environmental evaluations of these facilities. Depending on programmatic decisions from this PEIS, DOE will conduct site-specific tiered NEPA analyses in the future. For the CANDU Reactor Alternative, a representative site (Bruce-A Nuclear Generating Station, Province of Ontario, Canada) is being considered for analysis. For the Partially Completed LWR Alternative, a representative site (Bellefonte Nuclear Plant, Alabama) is analyzed. The immobilization alternatives could be performed in new or existing, modified facilities, using technology variants identified in Table 2.4–1. For the Electrometallurgical Treatment Alternative, ANL-W at INEL is the representative site for analysis. If the Electrometallurgical Treatment Alternative is selected in the ROD, additional construction and operational impacts would result if this alternative were implemented at other sites, and additional tiered NEPA analyses and documentation would be developed. For the vitrification and ceramic immobilization alternatives, impacts of new facilities are analyzed for six DOE sites. As an example of a technology variant at an existing facility, the can-in-canister technology variant at the DWPF at SRS is described in Appendix O.

Disposition Alternatives Considered But Eliminated From Further Analysis

Twenty-seven Pu disposition options were eliminated as follows:

Radiation Barrier Alloy for Indefinite Storage. This option was eliminated because it did not have an endpoint destination comparable to options such as direct disposal, immobilization, or reactor burning. The Screening Committee noted the material (a Pu-beryllium compound) would be in a form unsuitable for a civilian HLW repository unless reconverted to remove the Pu and process it into a repository-compatible waste form.

Injection Into Continental Magma. This technology was eliminated because it is very immature. A licensing and regulatory regime for the technology is undefined and uncertain, and its use would present several ES&H concerns.

Emplacement in the Sub-Seabed. This option was eliminated because the technical approach is immature and because a licensing and regulatory regime is undefined and uncertain, which also makes the schedule uncertain. Extended operations at sea would enhance the opportunities for a transportation vessel accident in which material lost at sea could be available for retrieval. Public and international perceptions are also uncertain due to similar concerns as other ocean disposal options.

Launching to Deep Outer Space. This option was eliminated for a number of reasons. First, based on the U.S. experience to date, the risk of an explosion during launch and offsite dispersal of radioactive material would be much higher than the risks of accidents and dispersal of radioactive materials for other options. Second, if the space vehicle with its surplus fissile material payload failed to achieve orbit and reentered the atmosphere, the chances of other nations recovering the material would be enhanced and the chances of U.S. retrieval would be reduced. Also, this option would be more expensive and more time consuming to complete than many others.

Direct Immobilization With Radionuclides in Borosilicate Glass, Use of Retrofitted Defense Waste Processing Facility. This option was eliminated as unreasonable for reasons stated in the Screening Report.[6] Installing a specially designed melter for Pu immobilization remains unreasonable. However, it is reasonable to modify the DWPF for other variants of the vitrification and ceramic immobilization alternatives.

Reactor and Accelerator Options. Five new reactor and accelerator options requiring significant technology development, including three concepts with accelerators coupled to reactors, were eliminated primarily due to their technical immaturity and the attendant costly and lengthy development and demonstration effort that would be required to bring them to viable, practical status and enable disposition options to be initiated with certainty. Although these options hold promise of higher levels of Pu destruction than other reactor burning options, these alternatives involve significant time delay, increased cost, technical uncertainties, and are not as reasonable as the mature reactor burning options to achieve the Spent Fuel Standard. However, if some of these advanced concepts are developed and successfully demonstrated or operated (for commercial nuclear power) they may be considered for Pu disposition in supplemental NEPA documents.

These five options were as follows:

- Accelerator Conversion: Molten Salt Target
- Accelerator Conversion: Particle Bed Target
- Accelerator-Driven MHR
- Particle Bed Reactor
- Molten Salt Reactor

Consuming in Modular Helium Reactors. A reactor concept was evaluated that involves MHR coupled to closed cycle power conversion systems. This option is less technically mature than other available options using MOX fuel in operating water-cooled reactor plants. The MHR would use tested, but not fully demonstrated or proved, ceramic-coated plutonium dioxide (PuO_2) fuel particles in a graphite matrix. The power conversion system would use components that have neither been tested as a "system" themselves nor integrated with a

[6] In this option, the present DWPF at SRS would have a new, specially designed melter installed. Much of the supporting equipment would require major retrofitting for this application because DWPF was not designed for criticality control. Retrofitting the DWPF would create additional total personnel radiation exposure and would significantly interfere with its mission to stabilize and treat HLW, resulting in delays and cost escalation. Note that eliminating this "DWPF Upgrade" variant does not preclude other DWPF-related variants of the Vitrification and Ceramic Immobilization Alternatives (such as adding an adjunct melter adjacent to the DWPF, or the can-in-canister approach in the DWPF) if these other variants do not introduce increased radiation or Pu criticality concerns into the DWPF.

gas-cooled reactor system. The concept could achieve higher levels of Pu destruction than water-cooled reactors if this concept were developed and successfully operated. However, the technical uncertainty, cost, and time to develop, license, and successfully demonstrate or operate this new integrated reactor plant and power conversion system is not as reasonable as other reactor alternatives because Pu disposition can be accomplished using existing technologies. If this concept is developed and successfully demonstrated or operated for other missions, it may be considered for Pu disposition as well.

Advanced Liquid Metal Reactors with Pyroprocessing. Another reactor burning concept was evaluated that involves a variation of the integral fast reactor concept whereby an advanced liquid metal cooled reactor with a Pu alloy metal fuel would operate on a once-through cycle and then utilize pyroprocessing techniques to make a Pu-rich HLW form for potential disposal in a repository. This concept, which would use a reactor fuel cycle design still under development in a manner different from its intended purpose, would be more costly and more time-consuming than other reactor options. The development program was recently terminated by Executive and Congressional action. Since the Pu disposition can be accomplished using existing technologies, there is no justification for developing this advanced technology for the purpose of Pu disposition. However, if it is developed and successfully operated for other missions, it will be considered for Pu disposition.

Direct Emplacement (Without Immobilization) in a High-Level Waste Repository. It is highly unlikely that a determination of acceptability could be reached in a timely manner for this nonreference waste form for disposal in a HLW repository, should DOE decide to operate a HLW repository. Such a form would also require the safeguards and security requirements for weapons-usable material until the repository, currently planned to allow retrieval of spent fuel for about 100 years, is sealed.

Discard Surplus Plutonium in the Waste Isolation Pilot Plant. This option for surplus Pu would exceed capacity after meeting the needs for disposal of defense-related transuranic (TRU) waste, should DOE decide to proceed with the disposal phase of the Waste Isolation Pilot Plant (WIPP). This option would likely require amendment of the *Waste Isolation Pilot Plant Land Withdrawal Act*, associated regulations, and draft or pending regulatory compliance documents, and the planning-basis for WIPP Waste Acceptance Criteria (WAC), among other things.

Hydraulic Fracturing. This option (high-pressure injection of slurried materials into fractured shale formations) was previously tested and evaluated for civilian HLW disposal. The screening committee concluded that there was no assurance that the technical feasibility of this unproven option would be demonstrated in time for the option to be considered in the decision process. No engineered barrier would exist to prevent leakage into subsurface aquifers.

Injection of Slurry Into Deep Wells. This option, similar to the hydraulic fracturing, would not have an engineered barrier to prevent leakage into subsurface aquifers, would therefore pose unacceptable ES&H risks, and would be prohibited under current law.

Melting Into Crystalline Rock. Information previously developed in initially evaluating this approach for disposal of civilian HLW, which uses the heat from the fuel to melt into rock formations, was reviewed. It was concluded that the option is not technically viable for this disposition application because of major uncertainties. These include criticality concerns and difficulty in assuring that enough heat would be available from spent fuel (to be commingled with the surplus fissile materials) to melt the host rock.

Disposal Under Ice Caps. This option is not considered technically viable and poses unacceptable ES&H risks because ice caps in Greenland and Antarctica are not necessarily stable beyond a few hundred years. Reaching an agreement with Denmark to dispose of our nuclear materials on Greenland is not likely; a current treaty already prohibits leaving nuclear wastes in Antarctica.

Seabed Disposal and Controlled Dilution in Oceans. These options are unreasonable and were disqualified because they present ES&H concerns and are contrary to domestic and international laws, treaties, and policies. Because of increasing concerns about the pollution of marine environments with radioactive materials (ocean dumping of radioactive materials is prohibited), EPA has not issued any permits for ocean dumping or dispersal of radioactive materials in recent years. These options are inconsistent with the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, generally known as the London Dumping Convention, enacted in 1975 and amended in 1980 and 1993.

Underground Nuclear Detonation. This option is unreasonable and was disqualified because compliance with regulatory and licensing requirements is regarded as very uncertain, and compliance with ES&H regulations is unlikely for a new process of this type. In addition, the United States has a moratorium on underground nuclear testing and the President recently signed a Comprehensive Test Ban Treaty. The Screening Committee judges it unlikely that detonations for this application would be approved since such actions might undermine this national policy.

Naval Nuclear Fuel; Using Plutonium Fuel in Naval Reactor Plants. There is no design, testing, or demonstration experience with MOX fuel in naval reactors. Even if technical feasibility had been demonstrated, new classified fuel and reactor core fabrication plants would be required. Since these processes and facilities cannot be declassified, transparent confirmation of the process or final condition by international inspections would not be possible. Additionally, the number of new fuelings of naval reactor plants is so small that disposition of surplus Pu could not be accomplished in a reasonable timeframe.

Reprocessing: Using Plutonium Fuel in Existing or New Evolutionary/Advanced Light Water Reactors With Chemical Reprocessing of Spent Fuel. During reprocessing to separate Pu from spent fuel to fabricate more fuel, there are stages in the processing and handling when weapons-usable materials are more vulnerable to theft or diversion than the Stored Weapons Standard. Additionally, the time and cost required to design and construct reprocessing plants for this application are much greater than those for available, adequate options that meet the Spent Fuel Standard.

Advanced Liquid Metal Reactor With Recycle and Reuse of Metallic Alloy Fuel Elements. Based on recent DOE and Congressional action, development of the advanced liquid metal reactor/integral fast reactor concept is no longer being pursued due to a U.S. nonproliferation policy to not develop technologies that rely on Pu recycling. Since this is a relatively immature reactor concept that has not been demonstrated, and since Pu disposition can be accomplished using existing technologies, there is no justification for developing this advanced technology solely for the purpose of Pu disposition. [Text deleted.]

Glass Material Oxidation/Dissolution System. This option was eliminated due to timeliness and technical immaturity. The time required to complete the necessary R&D for this process is much longer than that for other alternatives and options.

Euratom Mixed Oxide Fuel Reactor Use. This option would involve the preparation of PuO_2 at a processing facility to be built in the United States, and transportation of the oxide to Europe where it would be fabricated into MOX reactor fuel assemblies and utilized as full-core MOX fuel loading in existing reactor facilities in one or more European countries. Final disposal of the spent fuel assemblies would be in Europe. Due to lack of capacity to complete the disposition mission, the institutional complexities such as transportation, security, and other geopolitical factors, this option was warranted unreasonable in light of the other alternatives considered.

Figure 2.1.4–2 shows the disposition options that were considered and rated based on the nine screening criteria and the principal reasons for disqualification or elimination.

2.2 NO ACTION ALTERNATIVE

The definition of the No Action Alternative as it relates to both surplus and nonsurplus Pu and HEU was discussed in Section 1.7. The baseline case for the No Action Alternative involves no disposition of surplus Pu and no change in the current storage sites for Pu and HEU. This case is analyzed and referred to as the No Action Alternative in this section. The Preferred Alternative for storage calls for continuing current storage (No Action) of surplus non-pit Pu materials at Hanford, INEL, and LANL, pending disposition.

The No Action Alternative for long-term storage would maintain storage of all weapons-usable fissile materials at existing storage sites using proven nuclear material safeguards and security procedures. This alternative assumes that the corrective actions necessary to ensure compliance with high-priority ES&H requirements identified in the *Plutonium Working Group Report on Environmental, Safety and Health Vulnerabilities Associated with the Department's Plutonium Storage* would be completed. Maintenance at these existing storage sites would be done as required to ensure safe facility operation for the balance of the facility's useful life. DOE would not undertake any new construction projects except those that are considered part of ongoing site operations as portrayed in individual site-specific EISs and site development plans.

Under the No Action Alternative, surplus and nonsurplus Pu materials would remain in place at LANL, RFETS, Hanford, INEL, Pantex, and SRS. HEU would continue to be stored in existing buildings at Y–12 at ORR. Under No Action, it is assumed that HEU from other sites in the DOE Complex would be relocated to Y–12. The Y–12 EA addresses the transportation of this material and the storage of the material for up to 10 years. Nonsurplus HEU would remain in storage at Y–12 under No Action. Nonsurplus HEU materials represent nuclear weapons, secondary components, naval nuclear fuel, and working material. Surplus HEU would be stored at Y–12 until the material is removed for disposition, as is described in the HEU Final EIS. As a result of the ROD from the HEU EIS, storage of some of this surplus HEU may extend past the 10 years specified in the Y–12 EA. Under No Action, the storage facilities would be maintained to ensure safe facility operation. Subsequent NEPA analysis would be performed for continued storage beyond the 10-year period analyzed in the Y–12 EA.

2.2.1 HANFORD SITE

Hanford Site, located in the State of Washington (Figure 2.2.1–1), had 11 t (12.1 tons) of Pu material in September 1994. Of this, approximately 4.0 t (4.4 tons) falls within the scope of this PEIS. This material is stored within the protected vaults and gloveboxes of the Plutonium Finishing Plant (PFP) complex located in the 200 West Area (Figure 2.2.1–2). The remaining Pu materials currently within the PFP consist of solutions and numerous solid compounds such as metals, oxides, fluorides, mixed (Pu and uranium) oxide residues containing less than 50 percent Pu such as ash, and other Pu-containing materials such as plastics and combustibles. Pu inventories associated with irradiated fuel, buried or retrievably stored solid waste, liquid tank and waste residues containing less than 50 percent Pu, are outside the scope of this PEIS.

Preferred Alternative: No Action. Under the No Action Alternative, Hanford would continue to store Pu-bearing materials in the storage vaults and approved vault-type rooms of the PFP that have been assessed in the *Plutonium Finishing Plant Stabilization Final Environmental Impact Statement* (PFP EIS) (DOE/ EIS-0244D).[7] The *DNFSB Recommendation 94-1 Hanford Site Integrated Stabilization Management Plan* (VHC-EP-0853) calls for transforming the Pu-bearing materials to a stable form that meets the DOE standard *Criteria for Safe Storage of Pu Metals and Oxides* (DOE-STD-3013-94) by 2002 for materials with greater than 50-percent Pu. Some PFP plant systems that provide basic facility services (such as power,

[7] All Pu materials (both greater than and less than 50-percent Pu) would be stabilized and repackaged, as necessary, to ensure safe storage. The cleanout, stabilization, and storage of readily retrievable Pu materials in the PFP have been assessed in the *Plutonium Finishing Plant Stabilization Final Environmental Impact Statement* (PFP-EIS) (DOE/EIS-0244D). Hanford would continue to store residues containing less than 50 percent, which are not within the scope of this PEIS.

ventilation, and heat) would be upgraded for storage operations under the No Action Alternative. [Text deleted.] Hanford would continue to store residues containing less than 50 percent Pu. The unirradiated FFTF fuel pins and assemblies are acceptable "as is" for long-term storage. No further actions are envisioned for these unirradiated materials under the No Action Alternative.

[Text deleted.]

2.2.2 NEVADA TEST SITE

Nevada Test Site, located in the southern part of Nye County in southern Nevada (Figure 2.2.2–1), does not currently store any Pu or HEU within the scope of this PEIS. [Text deleted.] Due to existing available storage space within the P-Tunnel Facility, NTS is being considered for the long-term storage alternatives involving the consolidation of Pu and the collocation of Pu and HEU. These alternatives are described in Sections 2.3.2 and 2.3.3. Site designations and principal facilities at NTS are shown in Figure 2.2.2–2.

Preferred Alternative: No Action. DOE would not add Pu to sites that do not currently have Pu in storage. NTS does not store any Pu within the scope of this PEIS. Therefore, NTS would continue to carry out projected missions described in Chapter 3.

2.2.3 IDAHO NATIONAL ENGINEERING LABORATORY

Idaho National Engineering Laboratory is located near Idaho Falls in southern Idaho (Figure 2.2.3–1). As of February 6, 1996, there were approximately 4.0 t (4.4 tons) of Pu stored in the Zero Power Physics Reactor (ZPPR) and Fuel Manufacturing Facility (FMF) vaults at ANL-W and 0.5 t (0.55 tons) of Pu located in the Idaho Chemical Processing Plant (ICPP). All of this material falls within the scope of this PEIS. Site designations and principal facilities at INEL are shown in Figure 2.2.3–2.

Preferred Alternative: No Action. Under the No Action Alternative, weapons-usable Pu material at ANL-W would continue to be stored in the material forms deemed most stable according to the *ANL-W Plutonium ES&H Vulnerability Assessment Plan* (October 31,1994). The proposed *Corrective Action Plan* for vulnerability (ANL-W-I-4), involving almost all Pu onsite, calls for the site to store the material in the ZPPR and FMF vaults and maintain accountability pending disposal direction from DOE. Other site corrective action plans deal with the remaining INEL Pu which is in considerably smaller amounts, such as 13 kilograms (kg) (29 pounds [lbs]) requiring repackaging, 70 grams (g) (2.45 ounces [oz]) of surface oxides removed from stored Pu metal and alloys, and 2.7 g (0.095 oz) in sodium test loops.

2.2.4 PANTEX PLANT

Pantex is located in the Texas Panhandle in Carson County along U.S. Highway 60, as shown in Figure 2.2.4–1. Almost all Pu at Pantex is in the form of pits from disassembled nuclear weapons. The Pu inventory of 66.1 t (72.8 tons) at Pantex in September 1994 was the total amount actually at Pantex plus the amount in DoD custody. Currently, Pantex has the physical capacity to store up to 20,000 pits, but DOE has agreed to store no more than 12,000, pending completion of the Pantex EIS. Site designations and principal facilities at Pantex are shown in Figure 2.2.4–2.

Under the No Action Alternative, all site Pu holdings specific to the Storage and Disposition Program would continue to be stored in the Zone 4 facilities. However, if the Stockpile Stewardship and Management Final PEIS preferred alternative for downsizing assembly/disassembly actions is selected and implemented, the Pu pit strategic reserve storage would be moved to Zone 12 by 2005. Pu-bearing materials at Pantex would continue to reside in the material forms and facilities deemed most stable according to the DNFSB *Recommendation 94-1 Pantex Corrective Action Plan*. In accordance with this plan, Pantex will correct ES&H vulnerabilities by improving management and training within the plant and improving some operating structures to reduce the probability of dispersing hazardous material. In order to avoid or greatly reduce the possibility that Pu would be dispersed outside an assembly cell in case of an explosion, facility utility penetrations have been sealed and door seals have been improved. [Text deleted.] To mitigate the consequences of the possible collapse of the roof over Bay 27 in Building 12-26 due to natural phenomena, updated procedures and processes and modification of equipment and facilities would be accomplished.

In concert with its corrective action plan, Pantex is taking to reduce the probability of an operational accident, human error, or equipment failure that could cause failure of pit cladding, and to mitigate the effects of pit cladding failure due to these or other causes, such as aging. Pits would be repackaged in the more robust AT-400A containment vessel, and storage is being converted to a configuration that allows for remote handling and surveillance. To reduce the probability of accident or human error, a more robust weapons operations safety process has been instituted for B61, W56, and W69 weapons dismantlements and will be implemented for others in the near future.

2.2.5 OAK RIDGE RESERVATION

Oak Ridge Reservation is located near Knoxville, Tennessee, as shown in Figure 2.2.5–1. There are two ORR sites that currently store fissile materials within ORR. These sites are Oak Ridge National Laboratory (ORNL) and Y–12. The positions of these sites on ORR are shown in Figure 2.2.5–2.

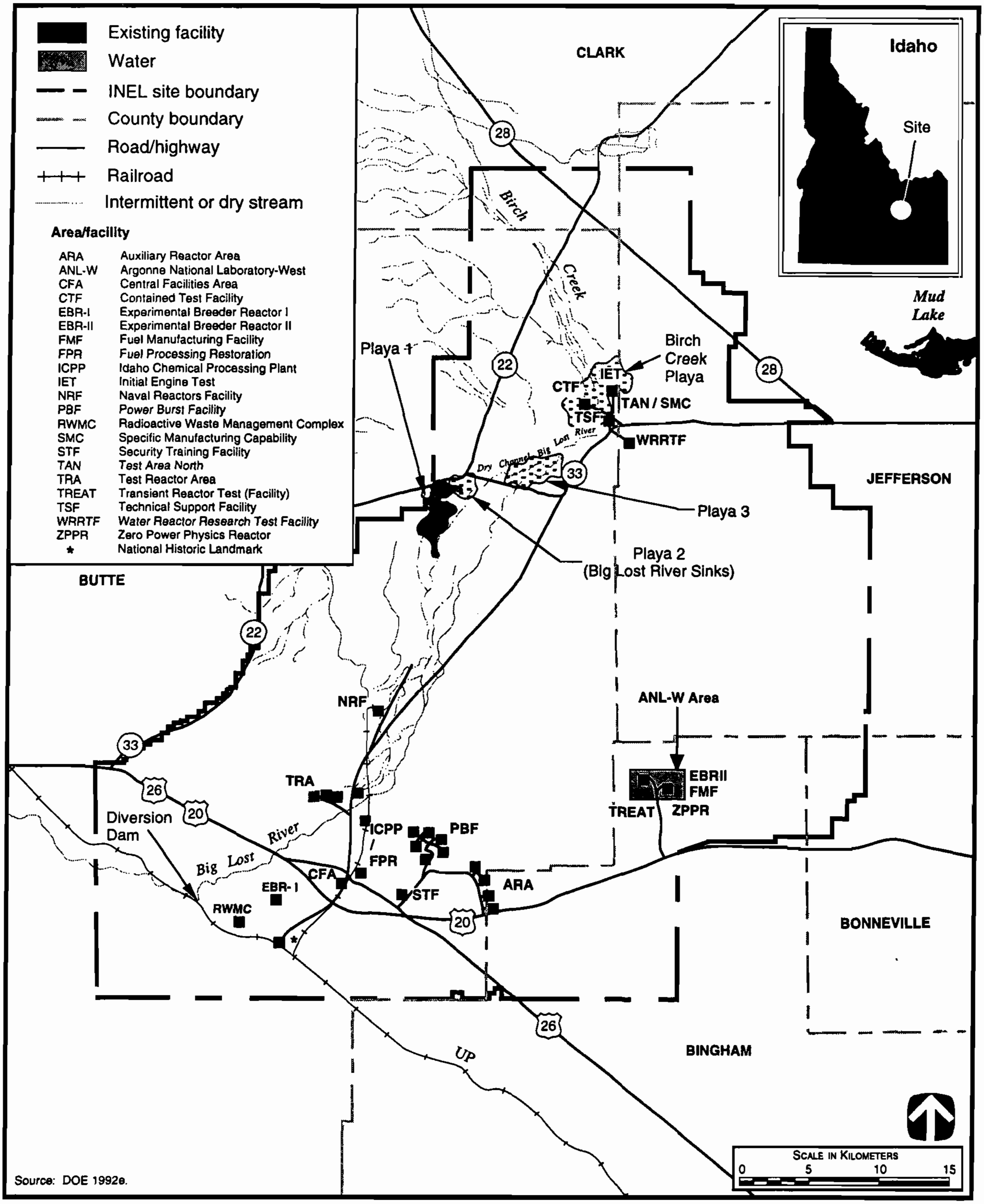

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Figure 2.2.3–2. Site Designations and Principal Facilities at Idaho National Engineering Laboratory.

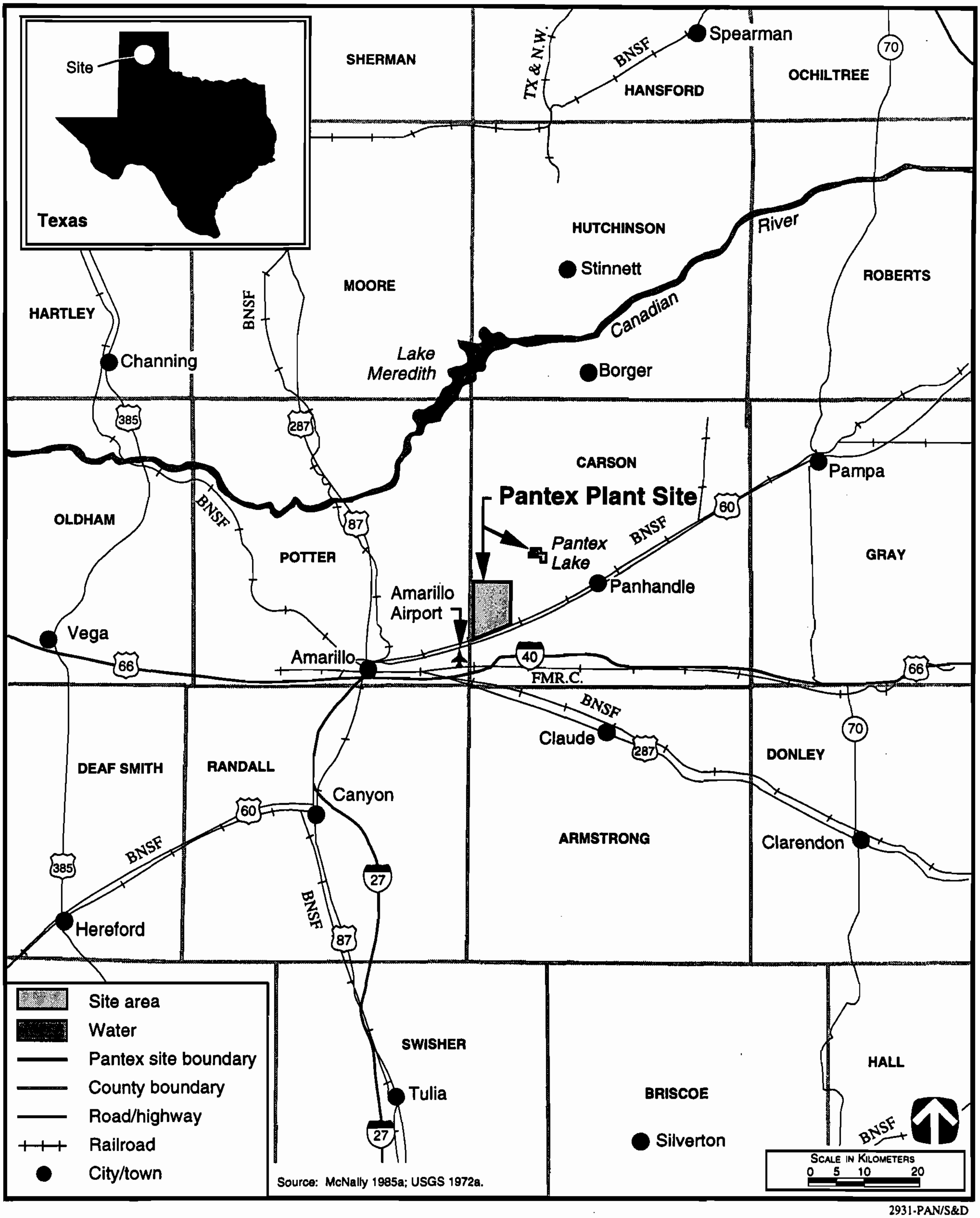

Figure 2.2.4–1. Pantex Plant, Texas, and Region.

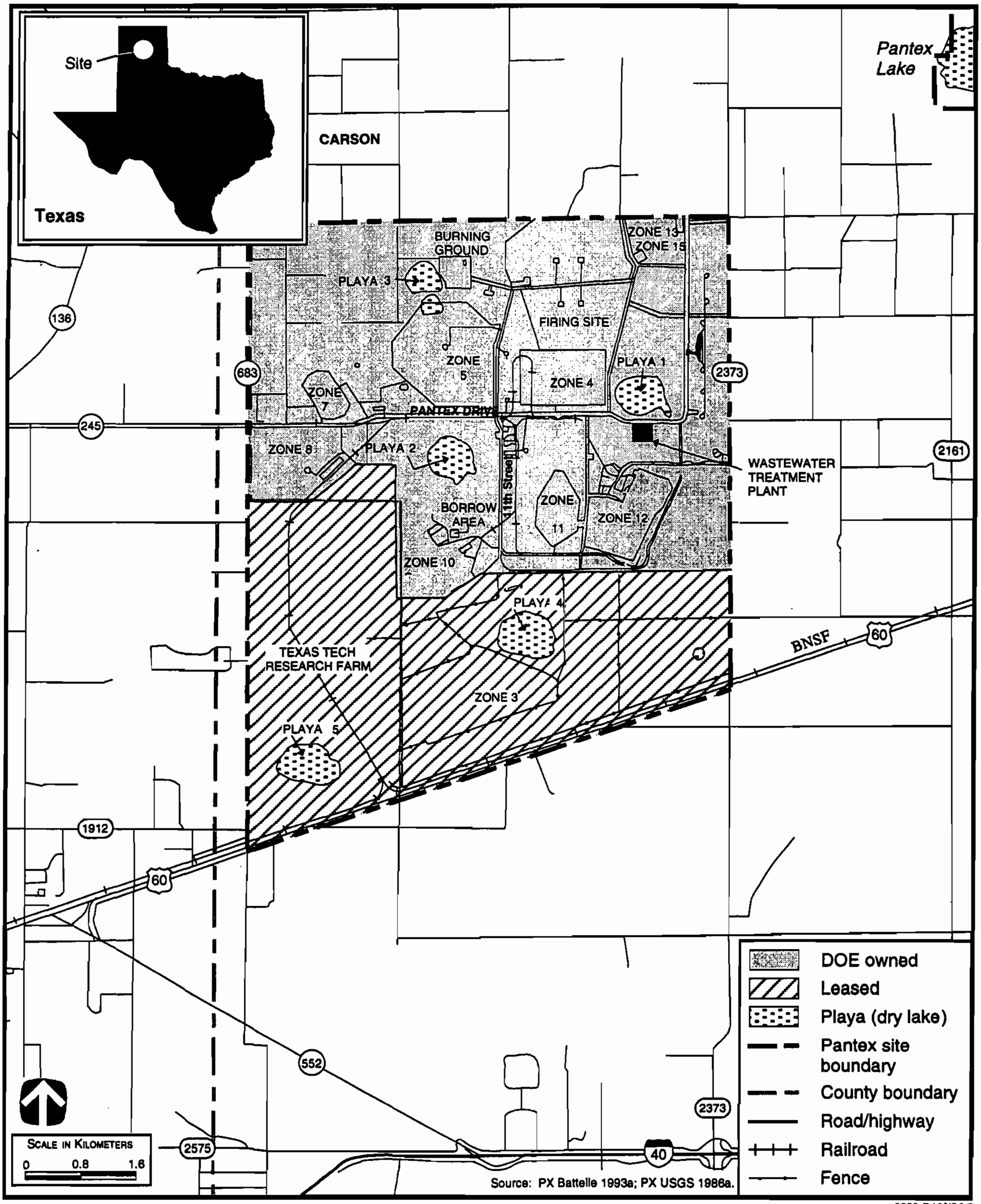

Figure 2.2.4–2. Site Designations and Principal Facilities at Pantex Plant.

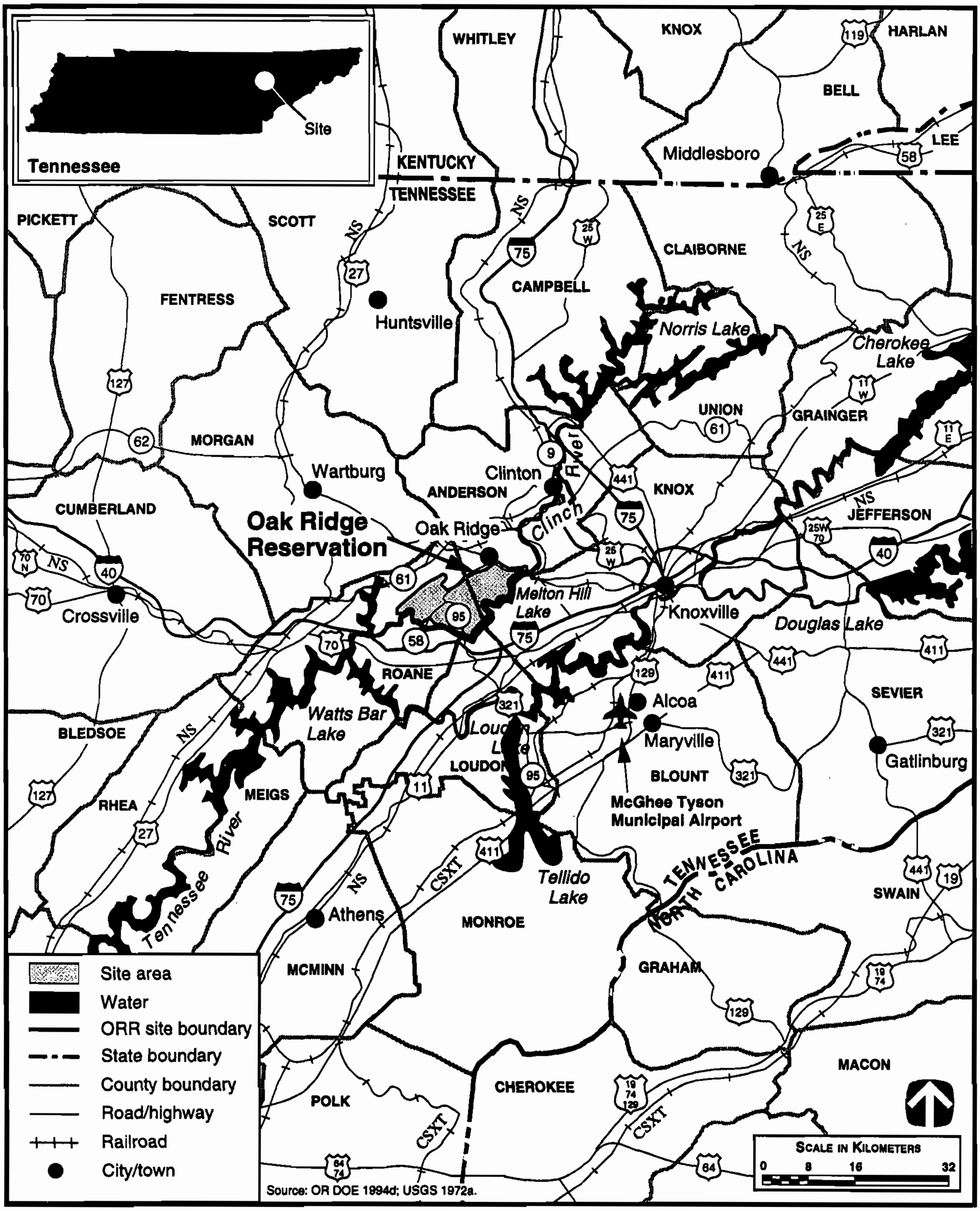

Figure 2.2.5–1.—Oak Ridge Reservation, Tennessee, and Region.

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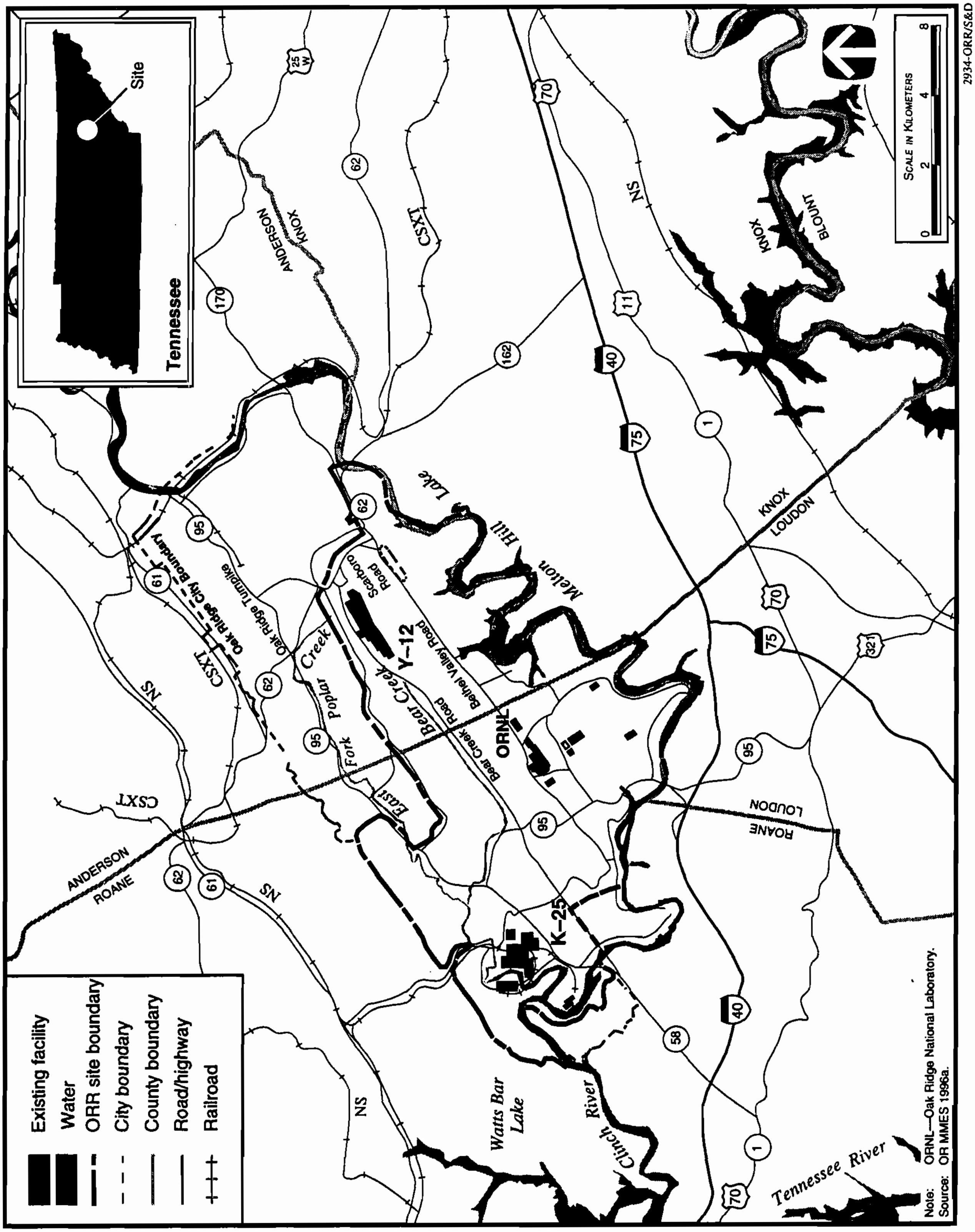

Figure 2.2.5–2. Site Designations and Principal Facilities at Oak Ridge Reservation.

As of September 1994, approximately 4.1 kg (9.0 lb) of Pu and 1 kg (2.2 lb) of collocated TRU waste was distributed among 19 facilities at ORNL and Y–12. This 5.1 kg (11.2 lb) is in various forms, including sealed sources, oxide, metal, solutions, and scrap/residues. Since the quantity of Pu stored at ORR is relatively insignificant compared to that located at other storage sites, and because it is in the form of waste, none of this material is within the scope of this PEIS.

All nonsurplus HEU currently stored at ORR is within the scope of this PEIS. Under the No Action Alternative, HEU would continue to be stored in existing buildings at Y–12. As of September 1994 the inventory at Y–12 consisted of 168.9 t (186.2 tons) of HEU. The bounding quantity (expected upper limit) of HEU that could be shipped to Y–12 from sites other than Pantex (whose quantity is classified) is an additional 98.4 t (108.5 tons).

Nonsurplus HEU would remain in storage at Y–12 under No Action. Nonsurplus HEU materials represent nuclear weapons, secondary components, naval nuclear fuel, and working material. Surplus HEU would be stored at Y–12 until the material is removed for disposition, as is described in the HEU Final EIS. As a result of the ROD from the HEU EIS, storage of some of this surplus HEU may extend past the 10 years specified in the Y–12 EA. Under No Action, the storage facilities would be maintained to ensure safe facility operation. Subsequent NEPA analysis would be performed for continued storage beyond the 10-year period analyzed in the Y–12 EA.[8]

2.2.6 SAVANNAH RIVER SITE

Savannah River Site, located south of Aiken, SC (Figure 2.2.6–1), had as of September 1994, 2.0 t (2.2 tons) of Pu material that falls within the scope of this PEIS, as well as other fissile materials in various forms which are outside the scope of this PEIS. The materials are in various forms, including Pu solutions, metal and oxides (more than 50-percent Pu), residues and oxides (less than 50-percent Pu), special isotopes, uranium, and spent nuclear fuel. Site designations and principal facilities are shown in Figure 2.2.6–2.

Under the No Action Alternative, SRS would continue to store Pu-bearing materials in the forms and facilities deemed most stable according to the *DNFSB Recommendation 94-1 Savannah River Site Integrated Stabilization Management Plan* (NMPP-PPLS95-0058) and in accordance with the *Spent Fuel Working Group Report on Inventory and Storage of the Department's Spent Nuclear Fuel and other Reactor Irradiated Nuclear Materials and Their Environmental Safety, and Health Vulnerabilities*, Volumes I, II, III, the *F-Canyon Plutonium Solutions Environmental Impact Statement* (DOE/EIS-0219, December 1994), the *Final Environmental Impact Statement, Interim Management of Nuclear Materials* (DOE/EIS-0220, October 1995), and the DOE standard *Criteria for Safe Storage of Plutonium Metals and Oxides* (DOE-STD-3013-94).

Under the No Action alternative, SRS would stabilize and store its various forms of Pu in accordance with the above listed plans for Pu materials as follows:

- *Pu-239 Solutions, F-Area.* The plan, supported by the *F-Canyon Plutonium Solutions Environmental Impact Statement* (DOE/EIS-0219) and the ROD dated February 1, 1995, was to convert this material to Pu metal. The conversion process in F-Canyon was completed in April 1996. The metal product will be stored temporarily in one of the F-Area vaults.

- *Pu-239 Solutions, H-Area.* In the *Final Environmental Impact Statement, Interim Management of Nuclear Materials* (DOE/EIS-0220) and the ROD dated December 12, 1995 (60 FR 65300), and supplemental ROD dated July 1996 (61 FR 6633), DOE determined procedures and processes for stabilizing stored nuclear materials, previously identified through independent reviews conducted by DOE and the DNFSB, that posed environmental, safety, or health vulnerabilities. A second

[8] Under No Action, DOE may, pursuant to appropriate NEPA review, propose to modify the Y–12 facilities or to build new facilities as necessary to ensure safe storage.

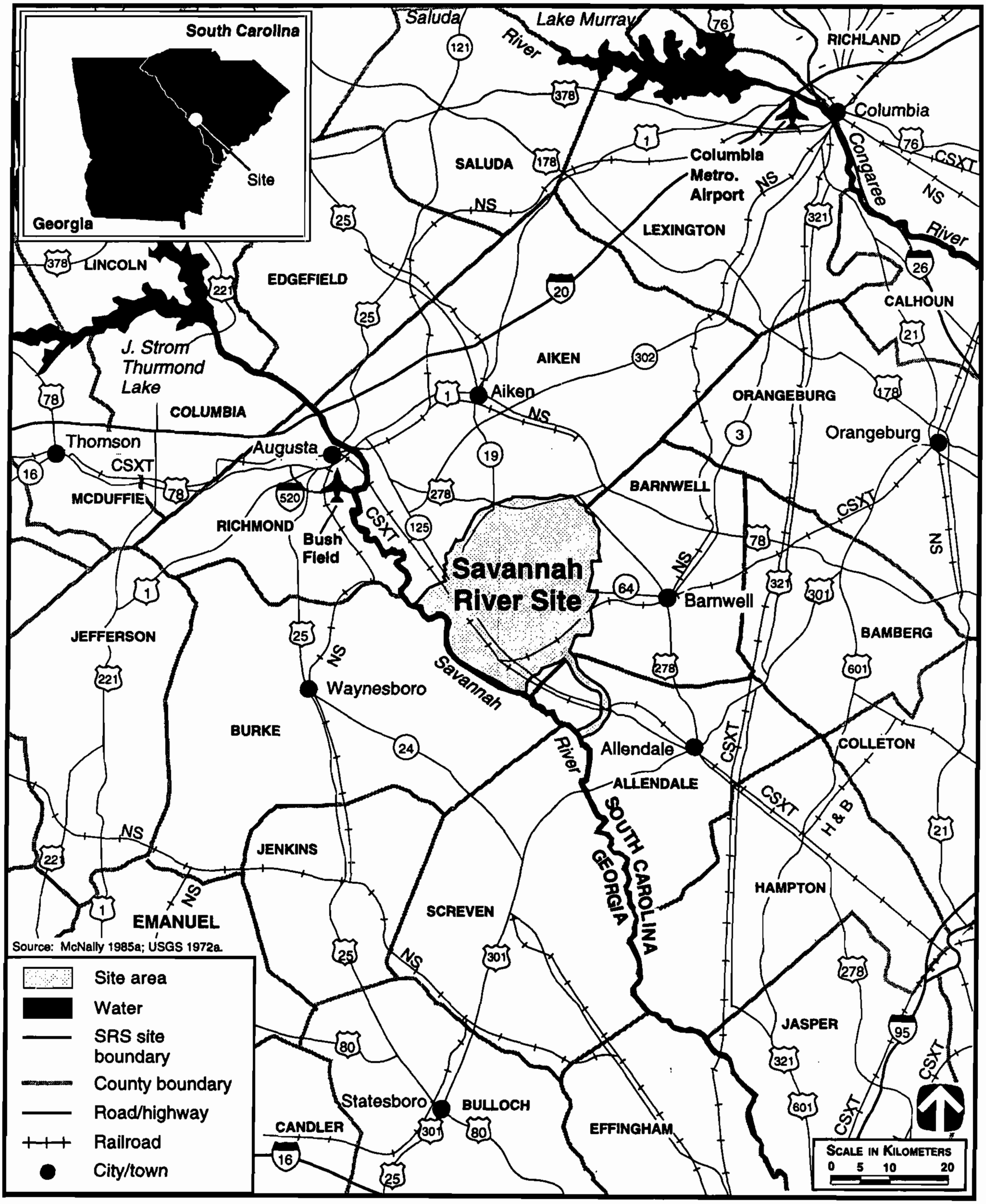

Figure 2.2.6–1. Savannah River Site, South Carolina, and Region.

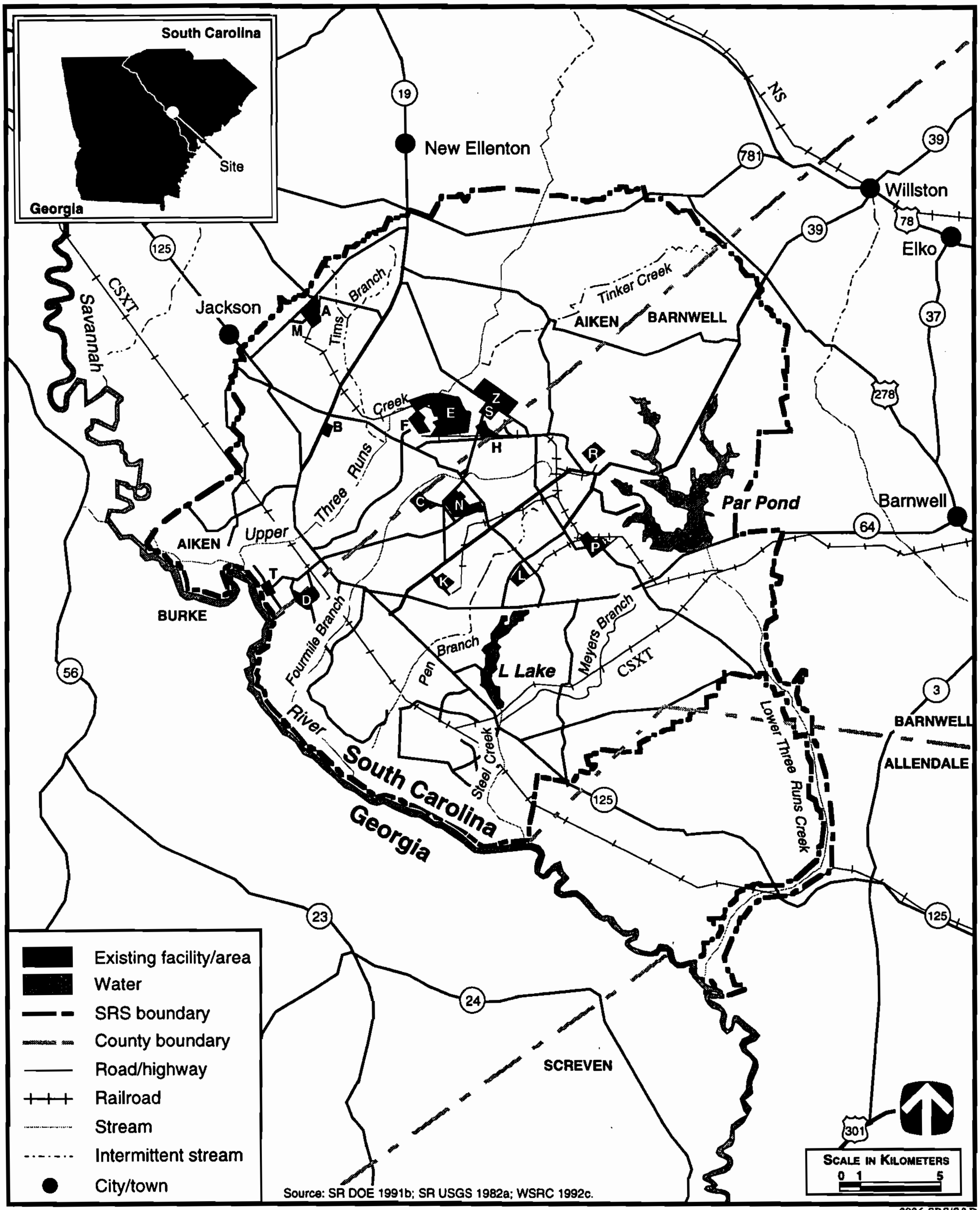

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Figure 2.2.6–2. Site Designations and Principal Facilities at Savannah River Site.

supplemental ROD announcing DOE's decision for the stabilization of Pu-239 solutions by conversion to metal at F-Canyon and the FB-Line was published September 13, 1996 (61 FR 48474 through 61 FR 48479).

- *Pu-242. The Final Environmental Impact Statement, Interim Management of Nuclear Materials* (DOE/EIS-0220) and the ROD dated December 12, 1995, categorized certain isotopes of Pu, neptunium, americium, and curium as programmatic. DOE has determined that the Pu-242 from SRS would be useful for future research and development activities.

- *Plutonium metal and oxide resulting from the stabilization actions at SRS.* This material would be stored in accordance with the DOE storage standard (DOE-STD-3013-94). In the ROD dated December 12, 1995, for the *Final Environmental Impact Statement, Interim Management of Nuclear Materials*, DOE decided to construct a new APSF in F-Area. This facility would enable SRS to stabilize and package Pu metals and oxides to meet storage criteria and also provide space for storage of all Pu and special actinide materials. The new facility is expected to be completed by 2001. In the interim, the Pu metals and oxides would be stored temporarily in one of the F-Area vaults.

[Text deleted.]

2.2.7 ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

Rocky Flats Environmental Technology Site, located in northern Jefferson County, Colorado (Figure 2.2.7–1), stored 12.9 t (14.2 tons) of Pu as of September 1994.[9] The Pu is in three basic forms: metals, oxides, and scrap/residues. The storage of the total Pu inventory at RFETS is within the scope of the storage portion of this PEIS. There are a small number of pits at RFETS that are surplus to national security needs but are still needed for ongoing, non-weapons-related R&D projects at LANL and LLNL. Therefore, these pits will not come within the scope of this PEIS until the R&D projects are completed. It is expected that this work will result in the transportation of these materials to LANL or LLNL, the conversion of the Pu into metal or oxide, and the return of the material to RFETS.[10] At that point, the materials will come within the scope of this PEIS and be stored and dispositioned in accordance with the decisions reached on the storage and disposition of surplus Pu in metal or oxide form. All Pu materials are stored in seven principal facilities: Buildings 371, 559, 707, 771, 776/777, 779, and 991. Site designations and principal facilities are shown in Figure 2.2.7–2.

In response to the DNFSB's Recommendation 94-1, and as addressed in the DOE *Plutonium Working Group Report on Environmental, Safety and Health Vulnerabilities Associated with the Department's Plutonium Storage*, the Pu metal and oxide at RFETS will be placed in a stable long-term (50-year) storage configuration. This storage configuration is in accordance with the DOE storage standard (DOE-STD-3013-94). DOE-STD-3013-94 does not apply to pits. In addition to the stabilization of this material, actions for resolving the Pu vulnerabilities have been identified as part of the RFETS *Site Integrated Stabilization and Management Plan*, and are being implemented.

Of the total amount of Pu in storage at RFETS, 11.9 t (13.1 tons) has been declared surplus to national security needs.[11] The amount of surplus in each of the basic forms is: metal 5.7 t (6.3 tons); oxides 1.6 t (1.8 tons); and scrap/residues 4.6 t (5.1 tons). Only a portion of the Pu is currently within the scope of this PEIS because the residues[12] are not in a weapons-usable form. Under proposed stabilization activities, all or portions of the non-weapons-usable material could be converted to a weapons-usable form.

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[9] Secretary of Energy's Openness Initiative, December 7, 1993.
[10] Under the Preferred Alternative, the RFETS material could be shipped directly from LANL or LLNL to Pantex.
[11] Secretary of Energy's Openness Initiative, February 6, 1996.
[12] Scrub alloy, ash, salts, dry residues, wet residues, and classified shapes.

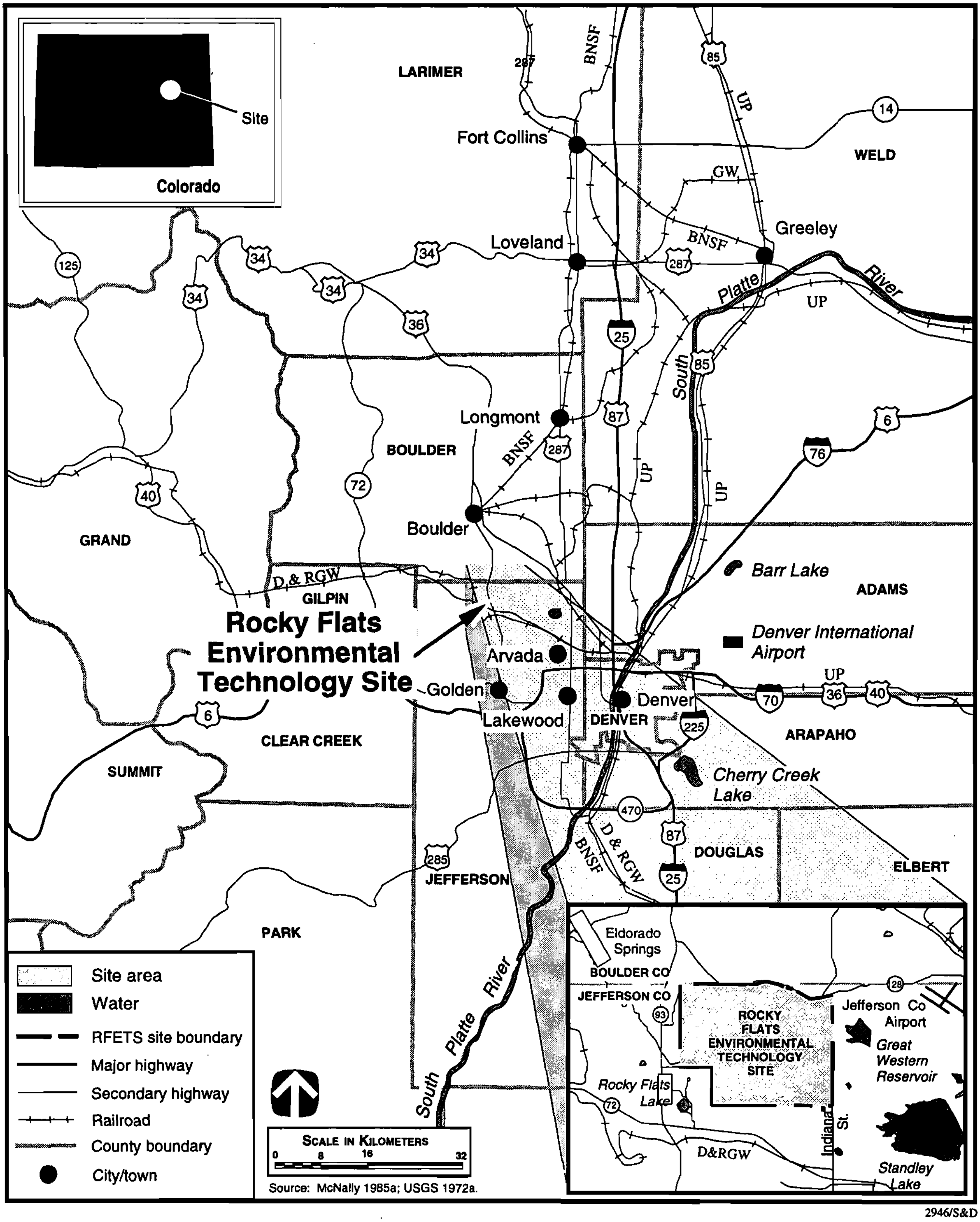

Figure 2.2.7–1. Rocky Flats Environmental Technology Site, Colorado, and Region.

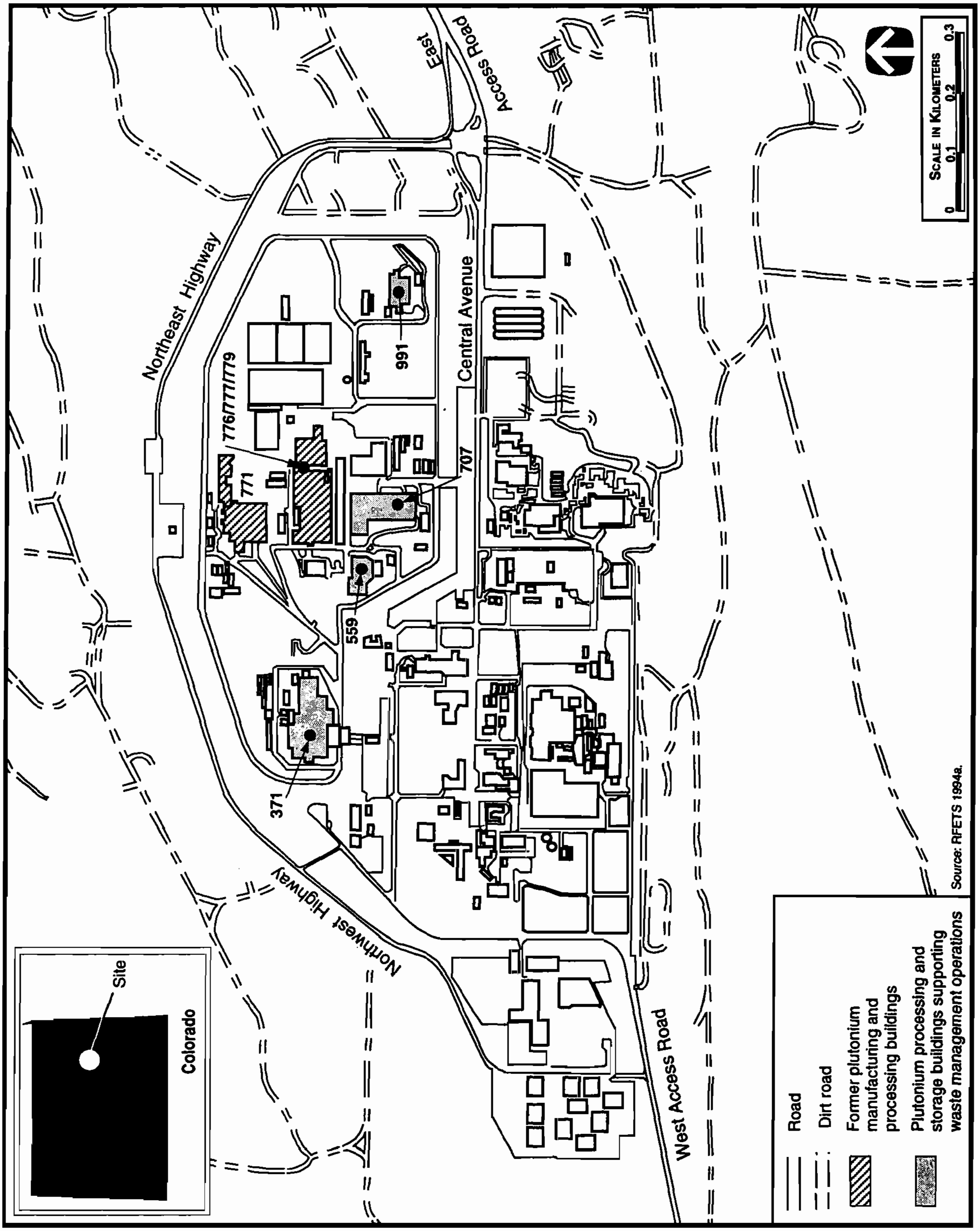

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Figure 2.2.7–2. Site Designations and Principal Facilities at Rocky Flats Environmental Technology Site.

Under the No Action Alternative, Pu-bearing materials at RFETS would be stabilized and converted to metal and/or oxide form and stored in existing, upgraded existing, or new facilities. Some Pu materials would be stabilized by conversion into a weapons-usable form and/or a waste form.

2.2.8 LOS ALAMOS NATIONAL LABORATORY

Los Alamos National Laboratory is located in north-central New Mexico adjacent to the town of Los Alamos, as shown in Figure 2.2.8–1. The Technical Areas (TAs) at LANL are shown in Figure 2.2.8–2. The inventory of Pu materials in storage at LANL as of September 1994, was 2.7 t (3.0 tons). This material is stored at 24 facilities and is in various physical and chemical forms, including metal, pits, fabricated weapons shapes, Pu compounds and alloys, and a broad range of scraps/residues (mostly solids). There are a number of sealed sources used for radiation instrument calibrations, neutron sources, and targets for experiments. In addition, small quantities of Pu exist in process equipment and at a few facilities within controlled access areas. Approximately 90 percent of the Pu at LANL is stored in packages located in TA-55. Of the total LANL Pu inventory, approximately 1.5 t (1.7 tons) falls within the scope of this PEIS.

Research at the TA-55 facility includes Pu recovery processes, Pu metal fabrication, Pu-238 general purpose heat source and radioisotope thermoelectric generation production, and advance fuel fabrication. Pu analytical operations are also conducted in the Chemistry and Metallurgy Research building, which has laboratories, hot cells, a waste assay facility, and a vault. The Los Alamos Critical Experiments Facility, remotely located in TA-18, uses Pu in nuclear criticality experiments.

Preferred Alternative: No Action. Under the No Action Alternative, weapons-usable Pu materials would continue to be stored in the upgraded Nuclear Material Storage Facility, in stabilized form pursuant to DNFSB Recommendation 94-1, within TA-55. Storage would be in accordance with LANL's proposed *Corrective Action Plan* for addressing ES&H vulnerabilities associated with Pu storage.

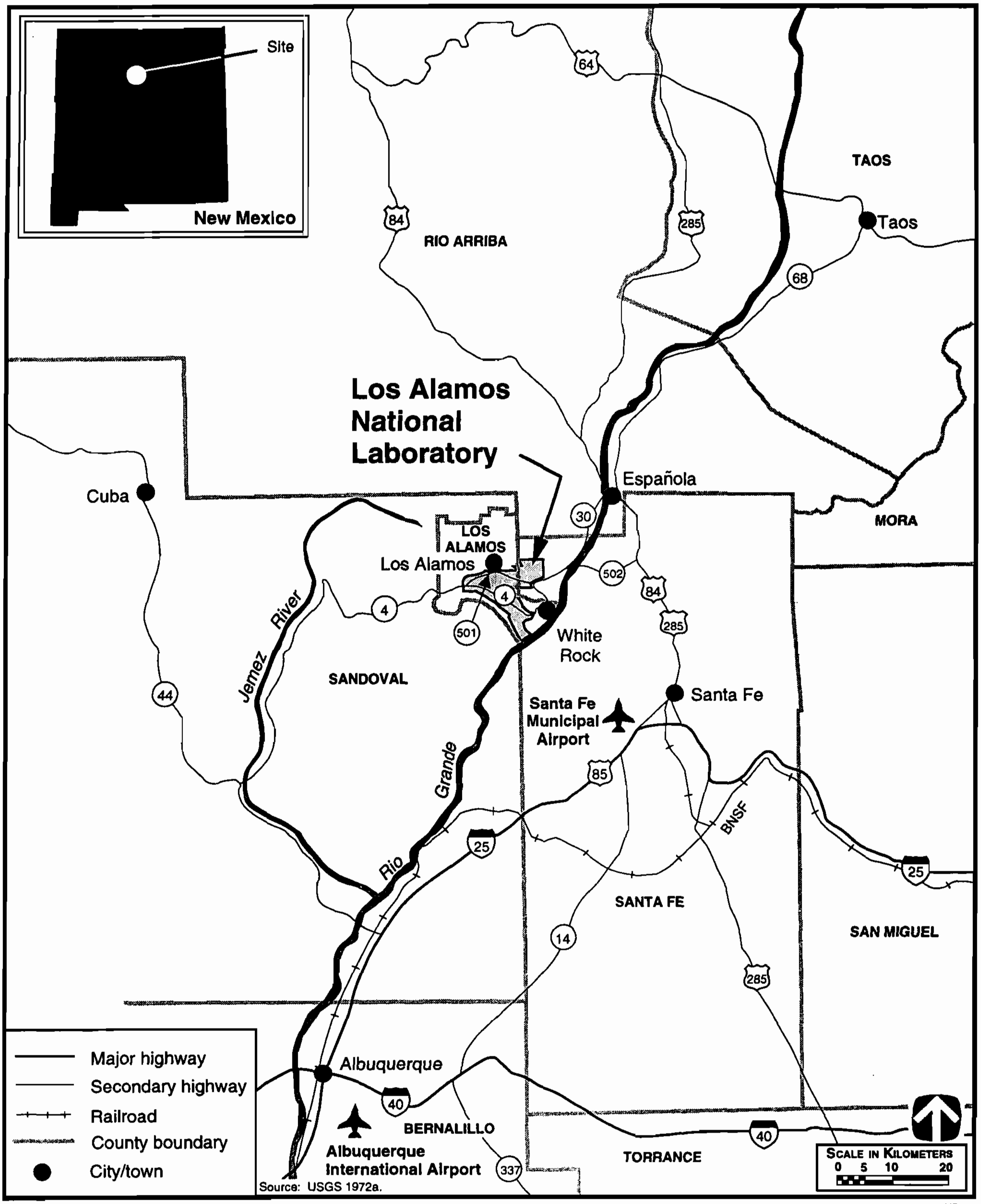

Figure 2.2.8–1. Los Alamos National Laboratory, New Mexico, and Region.

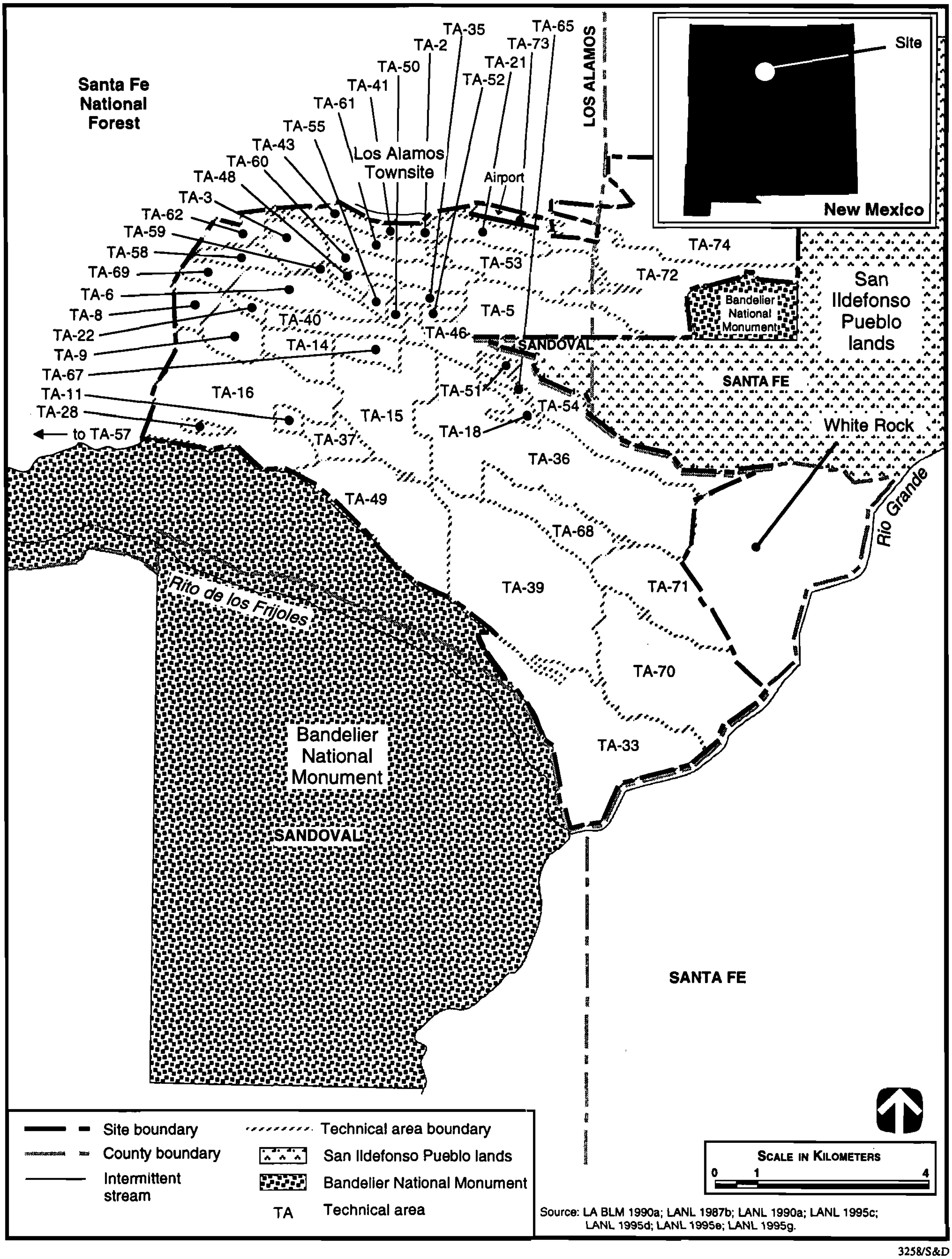

Figure 2.2.8–2. Site Designations and Principal Facilities at Los Alamos National Laboratory.

2.3 LONG-TERM STORAGE ALTERNATIVES AND RELATED ACTIVITIES

The long-term storage alternatives evaluated and discussed in this Storage and Disposition PEIS include the following:

- *Upgrade at Multiple Sites Alternative*—modify existing and/or construct new facilities at several DOE sites for continued storage of Pu and HEU; relocate all or some RFETS and LANL Pu to one or more of the Pu storage sites

- *Consolidation of Pu Alternative*—construct new facility, *or* construct new and modify existing facilities at one site for all Pu materials; modify or maintain existing HEU facilities at ORR

- *Collocation of Pu and HEU Alternative*—construct new facility, *or* construct new and modify or maintain existing facilities at one site for all Pu and HEU materials

Preferred Alternative for Storage: The Preferred Alternative for storage calls for (1) the upgrade of Zone 12 South facilities (to be completed by 2004) at Pantex to store strategic reserve pits, those surplus pits currently stored at Pantex, and pits from RFETS pending disposition; (2) the upgrade (expansion) of the APSF (planned to be built by 2001) at SRS to store those Pu materials currently at SRS, and surplus non-pit Pu materials from RFETS after stabilization is performed at RFETS; and (3) the upgrade of existing Y–12 facilities to store non-surplus HEU, and surplus HEU pending disposition.

Environmental impacts of each long-term storage alternative and the No Action Alternative are analyzed for each of the six candidate storage sites to allow the comparison of impacts by sites for each alternative and the comparison of impacts by alternatives for each site. As a result, decisions can be made to select a single storage alternative for all sites or a combination of different alternatives for different sites. In addition to the environmental analysis for storing all weapons-usable fissile materials under the scope of this PEIS under the No Action Alternative and the various long-term storage alternatives, an analysis of Pu storage without the nonsurplus materials covered under the Stockpile Stewardship and Management PEIS (strategic reserve and weapons R&D materials) is also presented. The impacts would generally be lower if these materials are not included.[13]

Conceptual facility locations for the long-term storage alternatives at Hanford, NTS, INEL, Pantex, ORR, and SRS are shown in Figures 2.3–1 through 2.3–6. [Text deleted.] Detailed descriptions of each long-term storage alternative are provided in the following sections. The descriptions, to the extent they describe new (not yet built) facilities or modifications, are based on conceptual designs and, depending on the strategy selected in the ROD, may be refined when more detailed designs become available.

2.3.1 UPGRADE AT MULTIPLE SITES ALTERNATIVE

The Upgrade at Multiple Sites Alternative includes four subalternatives. Under the first subalternative, Pu and HEU materials currently stored at five candidate DOE sites would remain in long-term storage at those sites in modified and/or new facilities. In addition, Pu material currently at RFETS and LANL, which are not candidate sites, would remain at those sites until decisions on the disposition alternatives are implemented.

The second subalternative includes relocating all or some of the Pu materials from RFETS and LANL to one or more of the upgraded long-term storage sites. For this second subalternative, all or some of the approximately 12.9 t (14.2 tons) of the Pu from RFETS Pu and 1.5 t (1.7 tons) of LANL surplus Pu material in storage would

[13] For the subalternatives that would not include strategic reserve and weapons R&D materials, a qualitative analysis for resources is presented.

be relocated to one or more of the upgraded candidate sites. A summary of the long-term storage options (facility requirements) by candidate site is presented in Table 2.3.1–1 [Text deleted.]

The third subalternative includes relocating Pu pits from RFETS to Pantex with storage of surplus pits pending disposition. Transfer of pits from RFETS would begin in 1997. Pits from Pantex and RFETS would be stored in Zone 4 until the facilities in Zone 12 South have been upgraded. The fourth subalternative would include relocating non-pit Pu materials from RFETS to SRS. Facilities in the F-Area at SRS would be modified to accommodate non-pit Pu from RFETS. This subalternative involves a similar but smaller expansion of facilities in F-Area compared to the second subalternative, which includes all or some of the Pu materials from RFETS and LANL. Requirements presented in Appendices B, C, D, E, and F reflect the various Upgrade at Multiple Sites subalternatives.

Table 2.3.1–1. Long-Term Storage Options for the Upgrade at Multiple Sites Alternative[a]

Candidate Site	Storage Option
Hanford	Modify Existing Fuels and Materials Examination Facility, or
	Construct New 200 West Area Facility for Continued Pu Storage
INEL	Modify Existing and Construct New ANL-W Facilities for Continued Pu Storage
Pantex (Preferred Alternative)	Modify Existing Zone 12 South Facilities for Continued Pu Storage
ORR (Preferred Alternative)	Modify Existing Y–12 Plant for Continued HEU Storage
SRS (Preferred Alternative)	Modify New Actinide Packaging and Storage Facility for Continued Pu Storage

[a] Proposed storage facility locations were primarily based on optimal use of existing facilities and are in accordance with current site development and utilization plans and proposals.

In addition to the environmental analysis performed for storing all weapons-usable fissile materials within the scope of this PEIS under this alternative, an analysis of the long-term storage of Pu and HEU without those nonsurplus materials covered under the Stockpile Stewardship and Management Final PEIS (strategic reserve and weapons R&D materials) is also presented as a subalternative to the Upgrade at Multiple Sites Alternative.

[Text deleted.]

Facility construction and operations data for the Upgrade at Multiple Sites Alternative at Hanford, INEL, Pantex, ORR, and SRS are listed in Appendix B, *Building and Facility Specifications*; Appendix C, *Materials, Resources, and Employment Requirements for Construction and Operations*; Appendix D, *Water Usage*; Appendix E, *Waste Management*; and Appendix F, *Air Quality and Noise*.

Hanford Site

Three options for onsite long-term storage of approximately 4 t (4.4 tons) of Pu materials were identified for the Hanford Site Upgrade Alternative. These include modifying current facilities at the PFP, modifying the as yet unused Fuels and Materials Examination Facility (FMEF), and constructing a new Pu storage facility. All three options appear realistically feasible and similar in total lifecycle cost. However, since lifecycle costs are similar, the PFP modification option was not specifically analyzed because of the potential difficulties associated with construction work within the PFP facility area and the risk of uncovering unexpected contamination during the modification activities. This leaves two options for consideration in this PEIS. The first option is to modify the existing FMEF. The second option is to upgrade Hanford's storage capability through new construction. The operational flow diagram is shown in Figure 2.3.1–1.

Modify Fuels and Materials Examination Facility. This option would utilize certain areas within the existing but as yet unused six-level, 18,600-square meter (m^2) (200,000-square foot [ft^2]) FMEF located in the 400 Area at Hanford (Figure 2.3–1). Figure 2.3.1–2 shows the plan view of the FMEF and surrounding buildings in the 400 Area. This location has a protected area with all required security features and necessary support utility services.The hardened outside walls of this facility are made of reinforced concrete and are designed to resist the forces of tornadoes and seismic events considered possible at Hanford. Modifying the FMEF would require minor demolition and stripping of some existing structures and utilities, and the possible addition of more radiation shielding. General renovation of laboratory areas would occur along with the addition of new equipment. Supporting office facilities would be provided in Buildings 4862 and 4706. A crane maintenance loft would be added, along with shielding and security hardening.

Secured storage vault space would utilize the FMEF main and decontamination cells within the 427 Building. The main cell would be modified to provide a vertical rack storage area. Shipping and receiving and other primary support functions would be housed in areas within the facility's hardened boundary. Utilization of the FMEF for the Upgrade Storage Alternative would not preclude its use to also support Pu disposition activities for either reactor or immobilization alternatives. This structure would meet all requirements of DOE O 430.1, *Life-Cycle Asset Management*, for Pu storage and handling. Pu handling capability would be accommodated by about 12 to 15 new gloveboxes in the hardened portion of the structure. These gloveboxes could also be used to directly support the Pu disposition operations. Modifications to the FMEF for storage would not preclude use of the FMEF for MOX fuel fabrication for the disposition alternatives.

Construct New Facility. Under this option, DOE would construct and operate a new two-story, stand-alone facility that would provide secured long-term vault storage as well as hardened and nonhardened long-term storage support space in a single building. The hardened portion of the facility walls and the vault walls would be made of reinforced concrete. Maintenance, utilities, process support, and access to the secured vault would be on the first floor. The second floor would house exhaust fans, filters, and the space for laboratory support.

The new long-term storage facility would be located adjacent to the current PFP protected area (PA) boundary in the 200 West Area at Hanford. Figure 2.3.1–3 shows the plan view of the proposed location for the new Hanford Pu storage facility in relation to surrounding buildings at the 200 West Area. This location has the advantage of allowing utilization of the existing secured PA, fences, and guards. In addition, movement of material from the present vaults into the facility would be more secure because of the collocation of vault facilities.

Support activities would be housed in the nonhardened portion of the new structure. These would include nonhardened utilities, offices for operations staff, and change areas. Existing Hanford facilities would be utilized for all required waste storage, handling, and disposal operations.

Nevada Test Site

This alternative does not apply at this site because neither Pu nor HEU is stored at existing facilities at NTS. Therefore, no facility is identified to be modified for continued storage of either material.

Idaho National Engineering Laboratory

The upgrade alternative at INEL would modify existing and construct new facilities for long-term storage of Pu located within the existing ANL-W facility at INEL as shown in Figure 2.3–3. The upgrade would be accomplished by constructing a new 2,650-m^2 (28,500-ft^2) material-handling building to augment existing buildings that would be modified for long-term storage and storage support. In addition, existing balance-of-plant (BOP) facilities at INEL would be used for support functions. The material handling, long-term storage, and storage support functions for the ANL-W upgrade would be provided by modifying Building 704 for long-term material storage, modifying Buildings 774 and 775 for storage support, and providing a new material handling building. The buildings would be interconnected by a new material transfer access corridor, with material handling lines and flow paths contained within one Materials Access Area (MAA). Figures 2.3.1–4 and 2.3.1–5 show the plan views of the ANL-W storage buildings in relation to the ZPPR building and other support buildings. The operational flow diagram is shown in Figure 2.3.1–6.

Pantex Plant

The upgrade alternative at Pantex would modify existing facilities in Zone 12 South. This alternative takes advantage of projected upgrade to support, security, and infrastructure systems for the assembly/disassembly operations at Pantex. The proposed location for this long-term storage option is shown in Figure 2.3–4. The modifications for long-term storage would be integrated into the Pantex infrastructure, security, waste, and assembly/disassembly operations systems. Upgrades of the Pantex assembly/disassembly operations include the upgrade of all support, security, and infrastructure systems needed for Pu storage operations. Therefore, the Pu storage upgrade is incremental to other planned upgrades at Pantex, and no additional upgrades of support systems beyond those identified for Pantex assembly/disassembly operations upgrade would be required. Figure 2.3.1–7 shows the plan view of the existing buildings in Zone 12 South (12-66 and 12-82 primarily) that would be modified for the Upgrade Alternative. The operational flow diagram is shown in Figure 2.3.1–8.

The modified facilities would provide staging capabilities to receive and ship approximately 3,000 shipping packages per year. The staging facility would include automated handling equipment to reduce radiation exposure. The long-term storage vault would be a modular design. It would incorporate remote operations to reduce the radiation exposure to personnel and enhance safeguards for the material. The vault would have a storage capacity of approximately 20,000 surplus material positions and approximately 5,000 nonsurplus material positions.[14]

In keeping with the primary objective to provide safe, secure, environmentally sound, and long-term storage of Pu pits from nuclear weapons, the upgrade would divide operations into three primary systems: a shipping/receiving and packaging system, a long-term storage vault system, and an abnormal package handling system. Currently, Pantex possesses the capability to overpack failed pit containers for offsite remediation. Under the preferred alternative, pits from RFETS would be stored similar to those currently stored at Pantex. No additional capability would be required to overpack failed pit containers since this capability already exists at Pantex. No capability exists for onsite remediation or overpacking of metal and oxide containers.

The majority of the pits at RFETS are already in a shippable form. For the small number of pits that are not currently in shippable condition, DOE would place these pits in a shippable condition prior to shipment to Pantex, in accordance with existing procedures. All of these pits are types which are currently stored at Pantex or have been stored there in the past. No capability exists for onsite remediation or overpacking of metal and oxide containers. If RFETS and/or LANL metal and oxide materials were moved to Pantex, processing equipment and space would be provided at Pantex to add the capability to either remediate or overpack any failed metal and oxide containers.

Preferred Alternative: Upgrade with RFETS Pu Pits Subalternative. The Upgrade with RFETS Pu Pits Subalternative would transfer Pu pits from RFETS to Pantex with storage of surplus pits continuing until disposition. Pits to be transferred would be packaged in FL (Type B) containers at RFETS before shipment and, upon receipt at Pantex, would be repackaged into AL-R8 containers in Zone 12 South and placed into storage in Zone 4 West pending availability of AT-400A containers and relocation to upgraded storage facilities in Zone 12 South. Storage of Pantex pits at Zone 4 West is analyzed in the Pantex EIS and storage and intrasite transportation of RFETS pits at Zone 4 West are described in Appendix Q. The intersite transportation analysis for shipment of the RFETS Pu to Pantex is given in Section 4.4 of this PEIS for both workers and the public. The transportation of existing Pantex pits between Zone 4 and Zone 12 and the repackaging of the pits from AL-R8 to AT-400A containers is analyzed in the Pantex EIS.

[14] A storage position is a volume defined by the dimensions 45.7 centimeters (cm) x 45.7 cm x 61 cm (18 inches [in] x 18 in x 24 in).

Oak Ridge Reservation

Preferred Alternative: Upgrade. Under the Upgrade Alternative, the entire HEU inventory requiring long-term storage would be stored at Y–12 in modified existing facilities as shown in Figure 2.3–5; no new facilities would be built. The majority of the HEU would be housed in facilities currently used for HEU storage. The remaining HEU would be stored in facilities that were formerly used for material processing, but are currently being modified and converted into storage areas. Modifications to existing buildings that would be required to make the facilities suitable for long-term storage consist primarily of those upgrades required to meet natural phenomena requirements as documented in *Natural Phenomena Upgrade of the Downsized/ Consolidated Oak Ridge Uranium/Lithium Plant Facilities* (Y/EN-5080, 1994) and the Y–12 EA as follows:

- Building 9204-2: Seventeen concrete beams supporting the second floor need strengthening by the addition of steel beams. The steel beams would be placed directly below the existing columns, and grout packed between the concrete and the steel beams. All of the crane bay columns located on column lines J and K would be strengthened by adding concrete to the outside face of the columns. Shear walls to brace eight large columns between the first and second floors would also be provided.

- Building 9204-2E: The metal roof deck needs to be tack welded to existing purlins, and additional roof scuppers added.

- Building Complex 9212/9995: Modifications would be made to numerous columns, knee braces, and cross braces to provide proper stiffness and load distribution. Building 9995 in this Complex is structurally unique, and the structural frame needs to be strengthened with additional vertical braces; struts need to be welded to the roof beams and then bolted to the walls to provide out-of-plane support.

- Building Complex 9215/9998: Roof bracing would be added to the penthouse and columns and beams strengthened by adding steel plates to them. Also, the roof deck would be tack welded to existing purlins, and additional corners and scuppers provided.

Figure 2.3.1–9 shows existing buildings at Y–12 that are proposed to be converted to long-term storage space for HEU.[15]

The material arriving at Y–12 (pursuant to the Y–12 EA) includes both surplus and nonsurplus HEU. Under the Upgrade Alternative, nonsurplus HEU would be retained in long-term storage. Surplus HEU would remain in interim storage at Y–12 until removed for disposition, as addressed in the HEU Final EIS. As the surplus HEU material is dispositioned over time, the total amount remaining in interim storage at Y–12 would decrease. As a result, environmental impacts associated with storing HEU materials at ORR would decrease as well.

Savannah River Site

Under the Upgrade With All or Some RFETS Pu and LANL Pu Material Subalternative, SRS would expand the APSF, which will be located north of the 235-F Building and east of the 247-F Building in F-Area as shown in Figure 2.3–6. The APSF will be a new building planned for completion by 2001. Thus, the Draft PEIS described this Upgrade Alternative as "construct a new long-term storage facility." DOE decided to construct the APSF in the ROD associated with the *Interim Management of Nuclear Materials Final Environmental Impact Statement* (DOE/EIS-0220). Therefore, the Upgrade Alternative is more correctly described in this Final PEIS as an expansion of the APSF. The expansion would provide up to approximately 4,100 additional long-term storage

[15] The Department is pursuing the Stockpile Management Restructuring Initiative, which includes, among other things, the preparation of a Conceptual Design Report for these structural modifications. Approval of the Conceptual Design Report would result in budget funding request(s) for line item project(s) for some or all the structural upgrades described above.

positions for Pu material potentially relocated from RFETS and LANL. Figure 2.3.1–10 shows the plan view of the proposed location for the APSF expansion in relation to the surrounding buildings at the F-Area. The expansion site covers approximately 1,100 m^2 (11,900 ft^2), and would be protected by an appropriate security system with an entrance control facility and a central alarm station. The MAA portion of the Pu storage facility expansion would be a reinforced concrete structure. The staging operation would include confirmation measurement, packaging/unpackaging, abnormal package handling, and accountability measurement. Area would also be provided for safety evaluation systems and IAEA inspection. The operational flow diagram is shown in Figure 2.3.1–11.

Preferred Alternative: Upgrade with RFETS Non-Pit Pu Material Subalternative. The Preferred Alternative, a subalternative of the Upgrade Alternative, would involve a similar but smaller expansion of the APSF. The facility construction and operational data used for this subalternative is based on an APSF expansion sized to accommodate approximately 3,000 storage positions for the non-pit Pu to be relocated from RFETS.

2.3.2 CONSOLIDATION OF PLUTONIUM ALTERNATIVE

2.3.2.1 Common Activities and Facility Requirements

If a new consolidated Pu storage facility were chosen to store the entire DOE inventory of Pu within the scope of this PEIS, surplus and nonsurplus Pu would be removed from existing storage facilities and relocated to the new facility at one of six candidate DOE sites.

The consolidated Pu storage facility would provide safe, secure, long-term storage of DOE surplus and nonsurplus Pu materials. These materials would be either in the form of pits (from disassembled nuclear weapons) or nonweapon forms such as metals or oxides. The stand-alone facility would perform a number of major functions to accomplish the storage mission, including the following:

- Material handling operations consisting of shipping/receiving, truck unloading/loading, cargo restraint transporter handling, unpackaging/packaging, material confirmation, staging of nuclear materials, material control and accountability (MC&A) verification, stabilization, and repackaging of Primary Containment Vessel (PCV) contents

- Material storage operations consisting of long-term storage of Pu materials in a safe, secure vault, material long-term safety evaluations, and international inspection of surplus material

- Analytical laboratory operations to support long-term storage of Pu materials

- Waste management operations, as required, to prepare wastes generated at the storage facility for shipment to disposal facilities

- Storage support functions necessary to meet DOE requirements for ES&H, waste management, maintenance, and safeguards and security

The consolidated Pu storage facility would also satisfy a variety of functional and administrative requirements:

- The consolidated Pu storage facility would have a design life of 50 years.

- Shipping sites would be responsible for initially meeting all long-term storage acceptance criteria, including processing, packaging, and certification before shipment. Materials received at the consolidated Pu storage facility would not require reprocessing, repackaging, or recertification before transfer to long-term storage vaults unless an abnormal condition is detected.

- The consolidated Pu storage facility would have the capability to offer surplus materials for international inspection. Inspection of nonsurplus materials would not be provided.

- The total capacity of the consolidated Pu storage facility would be 40,000 positions. [Text deleted.] Of the 40,000 positions, 35,000 would be allocated to surplus material, and 5,000 to nonsurplus materials.

- The maximum receipt rate would be 6,000 shipping packages per year, ranging from 6,000 pits to 5,000 pits plus 1,000 non-pits. The consolidated Pu storage facility would have the capability to simultaneously ship and receive PCVs and shipping packages.

- Storage capacity of the consolidated Pu storage facility would be expanded incrementally. The minimum capacity required upon initial operation would be 15,000 positions for surplus material and 5,000 positions for nonsurplus materials.

- The consolidated Pu storage facility would include the minimum capabilities necessary for onsite stabilization and repackaging of PCVs damaged in storage during the life of the facility. The consolidated storage facility would be able to package damaged pit PCVs to the Department of Transportation (DOT) requirements for shipment. It would also have the capability to repackage the contents of damaged PCVs into new PCVs. The consolidated Pu storage facility would not rely on existing Nuclear Weapons Complex Pu processing capabilities for the stabilization and packaging of metals and oxides from damaged PCVs. The stabilization and packaging of metals and oxides from damaged PCVs would generate TRU, low-level, mixed TRU, mixed low-level, hazardous, and nonhazardous wastes as outlined in Appendix E

- LLW would be immobilized and disposed of at an existing, onsite LLW facility or shipped offsite to a DOE-approved LLW disposal facility, depending on each site-specific practice and on decisions made pursuant to the Waste Management PEIS and any site-specific NEPA documents

- TRU waste and mixed TRU waste would be treated, packaged, and shipped offsite for disposal depending on decisions pursuant to the WIPP PEIS and the Waste Management PEIS

- Mixed LLW would be treated and disposed of offsite in accordance with site-specific treatment plans that were developed pursuant to the *Federal Facility Compliance Act* of 1992 in coordination with the EPA and State regulatory agencies and in accordance with decisions pursuant to the Waste Management PEIS

- Hazardous waste would be treated and disposed of through the use of *Resource Conservation and Recovery Act* (RCRA)-permitted facilities in accordance with site-specific practice. Temporary storage for up to 90 days would be provided as part of the facility design

- Sanitary solid and industrial solid wastes would be either disposed of at an existing, onsite, sanitary waste landfill or shipped to an offsite landfill, depending on each site-specific practice

To accomplish its mission, the consolidated Pu storage facility would require a main storage building and service support buildings and functional areas to support the storage function. The consolidated Pu storage facility would share security force, fire department, domestic water treatment, wastewater treatment, and utility distribution system services with other facilities onsite, as appropriate.

The storage facility conceptual design consists of a multilevel Pu storage building that would provide all required storage and support functions. This building would have three primary functions: material storage, material handling, and support. Three secondary functions would include repackaging, analytical laboratories, and waste management. Each of these six functions would be, in turn, supported by several service facilities, including fire protection, ES&H, safeguards and security, utilities, maintenance, and waste management. The MAA would house the nonsurplus material vault, the surplus material storage vault, and areas dedicated to providing safety evaluation, international inspection, automated guided vehicle (AGV) aisles, and personnel corridors. The material handling area would contain areas for shipping/receiving, staging, packaging/unpackaging, temporary storage, processing/recanning, AGV maintenance, and various support functions required for the primary storage operations and functions within the MAA. The material handling portion of the Pu storage building would also contain the Safe Secure Trailers (SST) loading/unloading, commodity shipping/receiving, waste shipping, and electrical and equipment maintenance shops. The support area would include the main MAA portal, control rooms, change rooms, showers, waste management, offices, kitchen, and cafeteria.

There would be three general zones within the consolidated Pu storage facility: the Property Protection Area (PPA), the Limited Area (LA), and the PA. The Pu Storage Building, which would contain the stored Pu, the Pu handling function, and support function, would be located in the PA, a higher security area. The general BOP support functions would be located in the PPA. This area contains administration offices; health, safety, and environmental support laboratories and offices; fire protection; vehicle maintenance garage; water and sewage treatment facilities; warehousing; and other service facilities. An LA encloses the security center, with chainlink fencing and a guard station for both pedestrians and vehicles.

2.3.2.2 Site-Specific Requirements

Under this alternative, all surplus and nonsurplus Pu within the scope of this PEIS would be phased out of existing storage facilities and moved to a new long-term storage facility located at a DOE site. Hanford, NTS, INEL, Pantex, and SRS are candidate sites for the consolidated Pu storage facility. ORR is also a candidate site for the consolidated Pu storage facility. However, if Pu were consolidated at ORR, the presence of the HEU material already residing at Y-12 would create an HEU collocation condition. Since this alternative makes no provision to move the HEU material out of ORR, the Consolidation of Pu Alternative at ORR is described with the Collocation of Pu and HEU Alternative presented in Section 2.3.3.

Figure 2.3.2.2–1 shows the plan view of the conceptual design and layout for the new consolidated Pu facility. This layout is nearly identical for each candidate site. Slight variations are attributable to the BOP support buildings required at each site. The operational flow diagram is shown in Figure 2.3.2.2–2. A summary of the long-term storage options by candidate site is presented in Table 2.3.2.2–1.

Table 2.3.2.2–1. Long-Term Storage Options for the Consolidation of Plutonium Alternative

Candidate Site[a]	Storage Option
Hanford	Construct New Pu Storage Facility
NTS	Modify Existing Tunnel Drifts and Construct New Material Handling Building at the P-Tunnel, or
	Construct New Pu Storage Facility
INEL	Construct New Pu Storage Facility
Pantex	Construct New and Modify Existing Zone 12 South Facilities, or
	Construct New Pu Storage Facility
	[Text deleted.]
SRS	Construct New Pu Storage Facility

[a] Consolidation of Pu at ORR results in a HEU collocation condition. This is described with other HEU collocation subalternatives presented in Section 2.3.3.

Note: NA=not applicable.

At NTS, two options could be pursued. The first option is to modify and make use of the P-Tunnel. Figure 2.3.2.2–3 and Figure 2.3.2.2–4 show the plan views of the proposed locations and modifications at P-Tunnel and Area 12, respectively, for the storage vault and BOP support buildings that combine to form this consolidation alternative. Modified existing tunnel drifts could be used for storing surplus and nonsurplus Pu materials. The second option would be to construct a new consolidated Pu storage facility near the Device Assembly Facility (DAF) in Area 6.

At Pantex, two options could also be pursued. The first option uses modified existing facilities for nonsurplus materials in combination with a new vault to be built for surplus materials, all in Zone 12 South. Figure 2.3.2.2–5 shows the plan view of the proposed location in Zone 12 South for the new surplus Pu storage building, and Figure 2.3.2.2–6 shows the proposed modification in Zone 12 South for the existing building to be used for nonsurplus storage. Construction and modification of these buildings combine to form this Consolidation Alternative. The overall operational flow diagram for this option is shown in Figure 2.3.2.2–7. The second option would be to construct a new consolidated Pu Storage facility in Zone 12.

In addition to the environmental analysis for the long-term storage of all weapons-usable fissile materials within the scope of this PEIS at a consolidated Pu storage facility, an analysis of consolidated Pu storage without those nonsurplus materials covered under the Stockpile Stewardship and Management Final PEIS (strategic reserves and weapons R&D materials) is also presented as a subalternative to this alternative. Location options for all sites for the consolidation of Pu are also shown in Figures 2.3–1 through 2.3–6.

Construction and operations data for the consolidated Pu storage facility at Hanford, NTS, INEL, Pantex, ORR, and SRS are listed in Appendices B, C, D, E, and F.

2.3.3 COLLOCATION OF PLUTONIUM AND HIGHLY ENRICHED URANIUM ALTERNATIVE

2.3.3.1 Common Activities and Facility Requirements

If new consolidated Pu and new collocated HEU storage facilities are chosen to store the entire DOE inventory of Pu and nonsurplus HEU within the scope of this PEIS, all Pu and nonsurplus HEU would be removed from existing storage facilities and relocated to the new consolidated Pu and collocated HEU storage facilities at one of the six candidate sites. Surplus HEU would continue to be stored at Y–12. It is assumed that most surplus HEU from other sites in the DOE complex would already have been relocated to Y–12. Missions and functions resulting from construction and operation of a new collocated HEU storage facility are presented below.

The stand-alone facility would perform a number of major functions to accomplish the HEU storage mission in addition to those presented earlier for Pu storage in Section 2.3.2.1. These include the following:

- Material handling functions consisting of shipping/receiving, unpackaging/packaging, material confirmation, and preparation of nonsurplus HEU materials for long-term storage

- Material storage functions consisting of long-term storage of HEU materials in a safe, secure vault; material inventory evaluations; and MC&A verifications

- Storage support functions required to meet DOE requirements for ES&H, waste management, maintenance, safeguards and security, and BOP services

In order to fulfill its prescribed mission, the collocated HEU storage facility would also satisfy a variety of functional and administrative requirements:

- The collocated HEU storage facility would store HEU materials. HEU metal castings or loose HEU oxide powder would be contained in cans. Assembled components containing HEU would be contained in drums. There would be no uranium liquids or gases and no irradiated materials stored at the facility.

- The collocated HEU storage facility would have a design life of 50 years.

- The total capacity of the collocated HEU storage facility would be 6,000 positions for HEU cans and 8,500 positions for HEU drums. The number of cans and drums that would be placed in a single storage position would vary depending on the contents of individual cans and drums.

- The maximum receipt rate would be 2,900 shipping packages per year, ranging from 2,900 HEU cans to 2,900 HEU drums, or any mixture thereof. The facility would have the capability to prepare and ship packages.

- The collocated HEU storage facility would include capabilities necessary for repackaging and waste management.

To accommodate its mission, the collocated HEU storage facility would include a main storage building and all of the service support buildings and functional areas that support the storage function. These facilities are in addition to the consolidated Pu storage facility. The collocated HEU storage facility would share security force, fire department, domestic water treatment, sewage treatment, and utility distribution system services with other onsite facilities, as appropriate.

There would be three zones within the combined Pu and HEU storage facility: the PPA, the LA, and the PA. The consolidated Pu storage facility, the collocated HEU storage facility, and the material handling and storage support functions would be located in the PA, a higher security area. The general BOP support functions of the collocated HEU storage facility are shared and located in the PPA.

2.3.3.2 Site-Specific Requirements

Under this alternative, all nonsurplus HEU within the scope of this PEIS would be located on the same DOE site as the consolidated Pu storage facility described in Section 2.3.2. Hanford, NTS, INEL, Pantex, ORR, and SRS are candidate sites for the Collocation of Pu and HEU Alternative. Figure 2.3.3.2–1 shows the plan view of the conceptual design and layout for the new collocated Pu and HEU facilities. This layout is nearly identical for each candidate site. Slight variations are attributable to the BOP support buildings required at each site. The operational flow diagram is shown in Figure 2.3.3.2–2. A summary of these long-term storage options by candidate site is presented in Table 2.3.3.2–1.

Table 2.3.3.2–1. Long-Term Storage Options for the Collocation of Plutonium and Highly Enriched Uranium Alternative

Candidate Site	Storage Option
Hanford	Construct New Pu and HEU Storage Facilities
NTS	Modify Existing Tunnel Drifts and Construct New Material Handling Building at the P-Tunnel, or
	Construct New Pu and HEU Storage Facilities
INEL	Construct New Pu and HEU Storage Facilities
Pantex	Construct New Pu and HEU Storage Facilities
ORR	Construct New Pu Storage Facility; Maintain Existing (No Action) HEU Storage Facilities at Y–12 Plant, or Construct New Pu Storage Facility and Modify Existing (Upgrade) HEU Storage Facilities at Y–12 Plant, or Construct New Pu and HEU Storage Facilities
SRS	Construct New Pu and HEU Storage Facilities

At NTS, two options could be pursued. The first option would be to construct a new consolidated Pu storage facility and construct a new collocated HEU storage facility near the DAF in Area 6. The second option would be to make use of the P-Tunnel. Figures 2.3.3.2–3 and 2.3.3.2–4 show the plan view of the proposed locations and modifications at P-Tunnel and Area 12, respectively, for the storage vaults and BOP support buildings that combine to form this collocation of Pu and HEU option. Modified existing tunnel drifts could be used for storing surplus and nonsurplus Pu materials along with nonsurplus HEU materials. The operational flow diagram is shown in Figure 2.3.3.2–5.

If ORR were selected as the collocated Pu and HEU storage site, any one of three options could be pursued. These include constructing the consolidated Pu storage facility and continuing storage of HEU in existing (No Action) storage facilities at Y–12 (under the No Action Alternative, DOE would not undertake any new construction projects except those that are considered part of ongoing site operations to ensure continued safe, secure storage; however, any new facility construction deemed necessary to maintain safe, secure storage would be addressed in appropriate, individual, site-specific EISs and site development plans); constructing the consolidated Pu storage facility and upgrading HEU storage facilities at Y–12; and constructing the consolidated Pu storage facility and constructing a new collocated HEU storage facility at a location on ORR other than Y–12. Under all three of these ORR options, it is assumed that HEU from other sites in the DOE complex would already be relocated to Y–12.

If ORR were not selected as the collocated HEU storage site, all nonsurplus HEU within the scope of this PEIS would be phased out of Y–12 and moved to a new facility collocated with the consolidated Pu storage facility located at another DOE site. Surplus HEU would continue to be stored at Y–12 as described above.

At all other sites a new consolidated Pu storage facility and new collocated HEU storage facility would be constructed to satisfy requirements under this alternative. Locations of facilities under the Collocation of Pu and HEU Alternative are shown in Figures 2.3–1 through 2.3–6. In addition to the environmental analysis performed for the long-term storage of all weapons-usable fissile materials under the scope of this PEIS at a consolidated Pu storage facility and collocated HEU storage facility, an analysis of consolidated Pu storage without those nonsurplus materials covered under the Stockpile Stewardship and Management Final PEIS (strategic reserve and weapons R&D materials) is also presented.

Construction and operations data for the Collocation of Pu and HEU Alternative are listed in Appendices B, C, D, E, and F.

2.3.4 Storage Phaseout

For alternatives described in Sections 2.3.1, 2.3.2, and 2.3.3, storage of existing Pu and HEU materials at various sites may be partly or entirely phased out. For Pu, under the phaseout process, material within the scope of this PEIS would be removed from one or more of the current storage sites and dispositioned (surplus materials only), partially consolidated at more than one storage site (all materials), or fully consolidated at a single storage site (all materials). Phaseout could occur at more than one of these sites because surplus and/or nonsurplus Pu materials currently exist at Hanford, INEL (ANL-W), Pantex, SRS, RFETS, and LANL. For HEU, nonsurplus HEU, which consists of strategic reserves (nuclear weapon secondary components and working material), and naval nuclear fuel, would be removed from its current storage site (assumed to be Y–12 for all HEU by the time actions under this PEIS are begun) and transported to the storage site chosen for collocation of Pu and HEU.

Although Pu and HEU may be transferred from a shipping site to a receiving site, the shipping site may still store material outside the scope of this PEIS (for example, residues with less than 50 percent Pu, and irradiated fuel). In addition to the environmental analysis performed for storing all weapons-usable fissile materials within the scope of this PEIS under the various long-term storage alternatives, an analysis of Pu storage without those materials covered under the Stockpile Stewardship and Management Final PEIS (strategic reserve and weapons R&D materials) is also presented.

2.4 PLUTONIUM DISPOSITION ALTERNATIVES AND RELATED ACTIVITIES

As described in Section 2.1.4, nine alternatives, which can be grouped into three categories, were identified as reasonable for disposition of Pu. The three categories and the alternatives within them are as follows:

Deep Borehole Category

- *Direct Disposition Alternative*—direct emplacement to deep boreholes without immobilizing Pu forms
- *Immobilized Disposition Alternative*—immobilization of Pu forms without adding radionuclides and then emplacement into deep boreholes

Immobilization Category

- *Vitrification Alternative*—immobilization of Pu in a glass matrix with processing in a vitrification facility and then dispose in a HLW repository[16]
- *Ceramic Immobilization Alternative*—immobilization of Pu in a ceramic matrix with processing in a ceramic immobilization facility and then dispose in a HLW repository[16]
- *Electrometallurgical Treatment Alternative*—immobilization of Pu in a GBZ form in an electrometallurgical treatment facility and then dispose in a HLW repository[16]

Reactor Category

- *Existing LWR Alternative*—convert Pu into MOX fuel, use MOX fuel in existing LWRs, and then dispose of spent fuel in an HLW repository[16]
- *Partially Completed LWR Alternative*—convert Pu into MOX fuel, use MOX fuel in partially completed LWRs, which are completed under this program, and then dispose of spent fuel in a HLW repository[16]
- *Evolutionary LWR Alternative*—convert Pu into MOX fuel, use MOX fuel in evolutionary LWRs, and then dispose of spent fuel in a HLW repository[16]
- *CANDU Reactor Alternative*—convert Pu into MOX fuel, use MOX fuel in Canadian CANDU reactors, and then dispose of spent fuel in the Canadian spent fuel program

Preferred Alternative for Pu Disposition: A combination of reactor and immobilization alternatives. The Preferred Alternative calls for (1) immobilizing at least those Pu materials not readily suitable for MOX fuel using vitrification or ceramic immobilization and (2) converting pure Pu metal, including pits, and oxides into MOX fuel for use in existing reactors. Use of Canadian CANDU reactors would be retained in the event that a multilateral agreement is made among Russia, Canada, and the United States to implement this.

The number of years a specific facility is expected to operate is based on facility sizing and throughput capacities. Preconstruction activities would require about 5 years for all the alternatives.[17] Preconstruction activities for the deep borehole category may take longer and may require additional legislation and associated

[16] See Appendix H (appropriate regulatory section) for a discussion of how the NWPA, as amended, might apply for disposal in a HLW repository.
[17] Preconstruction activities include tests, demonstrations, licenses, and tiered NEPA activities.

regulations. About another 5 years would be required for construction, startup, preoperational testing, and operational readiness review for all the alternatives. Construction of completely new reactors or deep boreholes could take longer. The time required for operations of all alternatives will vary depending on the amount of Pu material remaining after stabilization activities and the size, number, and throughput capacities of disposition facilities. If one of the domestic Reactor Alternatives were chosen, the MOX-based spent nuclear fuel is assumed to remain in the spent fuel pool for up to 10 years before relocation to a HLW repository. If either of the Deep Borehole Alternatives were chosen, the time to emplace the surplus Pu would depend on the number of deep boreholes being drilled. For each alternative, if decontamination and decommissioning (D&D) is proposed in the future, such activities are estimated to require up to 5 years for all but MOX fuel fabrication and reactors, which could take up to 10 years. D&D would not be proposed for the borehole sites, but for long-term institutional control (for future deterrence), the Deep Borehole Alternatives would likely take longer. D&D, if proposed, would be preceded by appropriate NEPA analysis.

As the various disposition technologies evolve and are refined through further study, development, and design, processes and facility arrangements would be optimized. This optimization would include specific operational relationships of facilities common to the selected alternatives, such as pit disassembly/conversion and Pu conversion facilities. Because this refinement process is ongoing, information and data presented in the technical documents for some of the alternatives are updated from that which was initially presented in the data reports supporting this PEIS. However, this PEIS considers the updated information as well. [Text deleted.]

Each of the nine disposition alternatives can be implemented in a number of ways because each alternative merely defines the generic technology approach used to achieve the Spent Fuel Standard. For example, using different numbers of existing reactors to accomplish the mission or utilizing different Pu concentrations within a borosilicate glass formulation represent variations for the existing reactor and vitrification alternatives, respectively. Determining which of the many possible variants to analyze within the PEIS is a matter of engineering judgment. A list of possible variants to the nine disposition alternatives is shown in Table 2.4–1.

[Text deleted.]

Representative facility locations for analyzing Pu disposition alternatives at Hanford, NTS, INEL, Pantex, ORR, and SRS are shown in Figures 2.4–1 through 2.4–6. These locations include those for the pit disassembly/ conversion, Pu conversion, vitrification, ceramic immobilization, MOX fuel fabrication, and evolutionary LWR facilities. Locations for the deep borehole complex, commercial MOX fuel fabrication facility, and existing LWRs, are generic. At ORR, the representative site for the evolutionary LWR is on undeveloped land (see Figure 2.4–5). This site is not within the ORR boundary, but is owned by the Tennessee Valley Authority (TVA). A previous agreement between DOE and TVA has reserved the site for a nuclear application, and it is anticipated that the land area would be transferred from TVA to DOE. The Bellefonte Nuclear Plant, approximately halfway between Huntsville, Alabama, and Chattanooga, Tennessee, is the representative analysis site for the partially completed reactor alternative. INEL is the representative site for the Electrometallurgical Treatment Alternative. For the CANDU Reactor Alternative, the Bruce-A Nuclear Generating Station is the representative site for the analysis. The following sections describe the requirements for each disposition technology listed above.

[Text deleted.] Three Immobilization Alternatives and three reactor alternatives produce a waste form that could be suitable for disposal in a domestic HLW repository. Such a repository, if approved under the provisions of the NWPA and its amendments, would serve as the disposal site for commercial and DOE-owned spent nuclear fuel and HLW. DOE is currently characterizing the Yucca Mountain site for the repository. If the Secretary of Energy recommended the Yucca Mountain site for the repository, the recommendation would be accompanied by an EIS (the repository EIS), the NOI for which was published on August 7, 1995 (60 FR 40164). DOE completed scoping in Fiscal Year 1996 and will continue working the EIS given sufficient appropriations. The Yucca Mountain site has not yet been recommended by the President and approved by Congress; therefore, this Storage and Disposition PEIS does not analyze impacts to a repository. No waste forms are currently licensed for disposal

Table 2.4–1. Descriptions of Variants to Analyzed Disposition Alternatives

Alternatives	Possible Variants
• Deep borehole direct disposition	• Arrangement of Pu in different types of emplacement canisters.
• Deep borehole immobilized disposition	• Bucket emplacement of pellet-grout mix. • Pumped emplacement of pellet-grout mix. • Pu concentration loading, size and shape of ceramic pellets.
• New vitrification facilities	• Collocated pit disassembly, Pu conversion, and immobilization facilities. • Use of either Cs-137 from capsules or HLW as a radiation barrier. • Wet or dry feed preparation technologies. • An adjunct melter adjacent to the DWPF at SRS, in which borosilicate glass frit with Pu (without highly radioactive radionuclides) is added to borosilicate glass containing HLW from the DWPF. • A can-in-canister approach at SRS in which cans of Pu glass (without highly radioactive radionuclides) are placed in DWPF canisters which are then filled with borosilicate glass containing HLW in the DWPF (See Appendix O). • A can-in-canister approach similar to above but using new facilities.
• New ceramic immobilization facilities	• Collocated pit disassembly, Pu conversion, and immobilization facilities. • Use of either Cs-137 from capsules or HLW as a radiation barrier. • Wet or dry feed preparation technologies. • A can-in-canister approach at SRS in which the Pu is immobilized without highly radioactive radionuclides in a ceramic matrix and placed in which are then placed in the DWPF canisters that are then filled with borosilicate glass containing HLW (see Appendix O). • A can-in-canister approach similar to above but using new facilities.
• Electrometallurgical treatment (glass-bonded zeolite form)	• Immobilize Pu into metal ingot form. • Locate at DOE sites other than ANL-W at INEL.
• Existing LWR with new MOX facilities	• Pressurized or Boiling Water Reactors. • A different number of reactors. • European MOX fuel fabrication. • Modification/completion of existing facilities for MOX fuel fabrication. • Collocated pit disassembly/conversion, Pu conversion, and MOX fuel facilities. • Reactors with different core management schemes (Pu loadings, refueling intervals).
• Partially completed LWR with new MOX facilities	• Same as for existing LWR (except that MOX fuel would not be fabricated in Europe).
• Evolutionary LWR with new MOX facilities	• Same as for partially completed LWR.
• CANDU reactor with new MOX facilities	• A different number of reactors. • Modification/completion of existing facilities for MOX fabrication. • Collocated pit disassembly/conversion, Pu conversion, and MOX facilities. • Reactors with different core management schemes (Pu loadings, refueling intervals).

in a HLW repository. For the Immobilization Alternatives, legislative clarification or NRC determination by rule may be required before the immobilized Pu can be placed in an NWPA repository. Data to estimate waste forms under consideration in this PEIS for disposal in a repository are compared to data currently being evaluated for disposal in a NWPA-licensed repository. The results of this analysis are in Appendix H.

The fourth Reactor Alternative would use surplus U.S. Pu in MOX fuel for Canadian reactors, with the spent nuclear fuel managed by Canada. The MOX-based spent nuclear fuel from the alternative would be comparable to spent fuel from ongoing power producing operations in that country. This PEIS presents an analysis of domestic activities within the continental United States. A brief impact assessment of activities in Canada is included in Appendix I.

DOE would analyze the impacts of continued storage of immobilized Pu waste forms or MOX-based spent nuclear fuel in a tiered NEPA document under any of the following conditions: (1) if the DOE HLW Program changes its approach for disposal of commercial spent nuclear fuel, (2) if the timeframe for acceptance of waste by the program is significantly delayed beyond current projections, or (3) if the Pu immobilized waste forms or MOX-based spent nuclear fuel resulting from Pu disposition alternatives are not acceptable to a licensed repository.

Six DOE sites and other generic and specific sites were used for assessing the environmental impacts of various disposition technologies and strategies. The locations of the new facilities considered for the various disposition technologies are representative and for analysis purposes only. Until tiered NEPA documentation has been completed, no specific location within any specific site (or sites) will be selected for any disposition alternative action.

This Storage and Disposition PEIS assumes all surplus Pu could be processed through each of the various disposition technology alternatives. However, some surplus Pu material may not be suitable for processing under every disposition technology. As a result, the strategy for disposition of surplus Pu could involve a combination of disposition alternatives. In addition, if any of the LWR alternatives are selected, there is also a multipurpose reactor variant (see Section 1.4 and Appendix N) that could produce tritium, use Pu as fuel, and in some designs generate revenue through the sale of electricity.

No Plutonium Disposition Action

As discussed in Section 1.6, a "No Pu Disposition" action means disposition would not occur, and surplus Pu-bearing weapon components (pits) and other forms, such as metal and oxide, would remain in long-term storage in accordance with decisions on the long-term storage of Pu.

Activities Common to Multiple Plutonium Disposition Alternatives

As previously described, the disposition alternatives for surplus Pu involve a variety of technologies. However, two activities are common to all the disposition alternatives, including the Preferred Alternative:

- Pit disassembly/conversion
- Pu conversion

Since these common activities involve the conversion of surplus Pu from current forms to one suitable for disposition, they are essential components of each disposition alternative. Pit disassembly and Pu conversion facilities could be collocated. Multiple facilities located at the same site are analyzed in Section 4.7.3, and more specific analysis will be performed in tiered NEPA documents, as appropriate.

Upon completion of the pit disassembly/conversion and/or Pu conversion processes, the Pu materials would be ready for further actions under one or more of the disposition technology alternatives.

2.4.1 PIT DISASSEMBLY/CONVERSION FACILITY

The pit disassembly/conversion facility would be common to all disposition alternatives, including the Preferred Alternative. The facility would disassemble, reshape, and convert the pits into an unclassified metal or oxide form usable by the next facility in the disposition process. In addition, some non-pit material (such as pure Pu metal) may be processed at the pit disassembly/conversion facility. The material contained in the pit disassembly/conversion facility, would require the highest levels of protection.

In accordance with the Preferred Alternative for surplus Pu disposition, the pit disassembly/conversion facility could be located at either Hanford, INEL, Pantex, or SRS. Further tiered NEPA review will be conducted to examine alternative locations, including new and existing facilities, at these four sites should the Preferred Alternative be selected at the ROD.

Facility Description. The surplus Pu would be removed from the pits by separating them in half with a cutting wheel and subjecting each half to a dry chemical process that converts the metal to a hydride powder, then either back to metal or to an oxide powder. Figure 2.4.1–1 depicts the material flow through the facility.

The total disturbed land area for the operating facility would be approximately 12 hectares (ha) (30 acres), plus a 1.6-kilometer (km) (1-mile [mi]) buffer zone around the operating facility. Provisions would be included to accommodate future international treaty requirements for inspection. Figure 2.4.1–2 shows a conceptual site layout perspective.

[Text deleted.] Appendix B provides a more detailed breakdown of the key buildings required at the pit disassembly/conversion facility. These buildings and their missions include the following:

Plutonium Processing Building. Pits would be disassembled, and the Pu and other components would be separated in this building. All wastes would be processed here for disposal. In addition, the building would contain maintenance facilities, laboratories, utility systems, heating ventilation and air conditioning (HVAC) equipment, and other support functions.

Administration Building. Management offices, meeting and conference rooms, a visitor control office, and the cafeteria would be contained here.

Plutonium Operations Support Building. Change rooms, decontamination facilities, offices, maintenance shops, operator training rooms, process demonstration laboratories, and general storage areas would be located in this building.

Warehouse. This building would provide miscellaneous storage and general delivery areas.

Utilities Building. Steam and water treatment facilities, the plant air system, and the chilled water system would be located in this building.

Generator Building. Emergency generators would be located in this building.

Guard and Vehicle Monitoring Station. This building would serve as the pedestrian and vehicle entrance to the facility. A hardened guard booth and a vehicle entrance lane next to the pedestrian entrance would be provided.

Facility Operations. Wherever possible, operations would be conducted by automated and robotic systems to reduce personnel exposure. The facility would be designed for a throughput of 3.25 t (3.58 tons) of Pu per year, using two shifts per day, 5 days per week. Surge capability would be provided by increasing plant personnel and adding weekend work shifts.

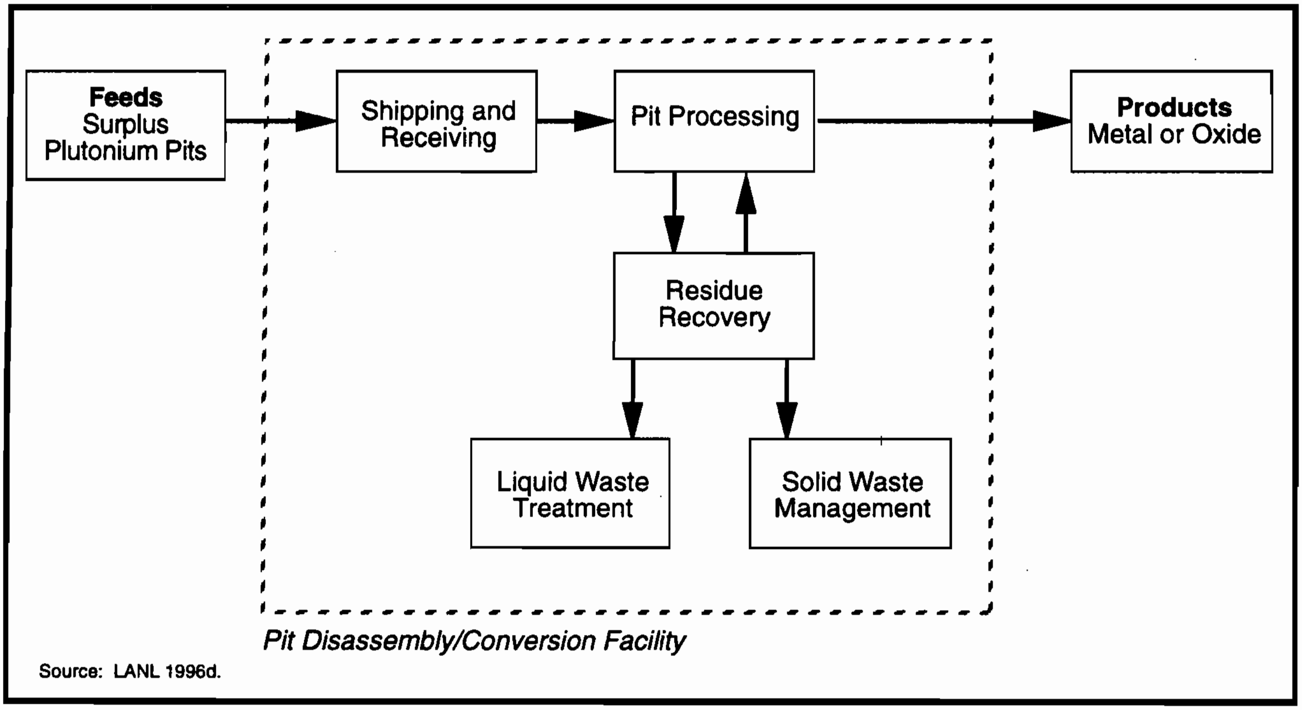

Figure 2.4.1–1. Pit Disassembly/Conversion Facility Material Process Flow.

The pit disassembly/conversion facility would contain all required systems to remove Pu from weapons components and to package the material into an unclassified form suitable for shipment to the next facility in the disposition process. Operational flow within the facility would be through several main processing areas. Shipping and receiving would handle the incoming pit inspection, decontamination, storage, and initial processing and the outgoing shipping functions for the Pu metal or oxide produced by the facility. Pit disassembly and conversion operations[18] would process the pit mechanically and chemically within gloveboxes into either Pu metal or oxide (depending upon the selected disposition process) and would package it for removal. Another output of the process would be waste, both liquid and solid, consisting of low-level, TRU, hazardous, and mixed waste. An analytical laboratory would be required to perform Pu assays on product and waste streams as well as to certify waste streams. A lag storage vault would be used to store product metal or oxide, uranium forms, and other components before packaging for shipment to the next disposition facility. Utilities and manpower resources needed during operation are presented in Appendix C. Chemicals required during operations can be found in the classified appendix. The water balance is depicted in Appendix D.

Construction. Construction of the facility would take approximately 6 years and have a peak annual employment of 125 construction workers. Construction of the pit disassembly/conversion facility would require an additional 2 ha (5 acres) of land for construction laydown, warehousing, and construction parking. Resources consumed during construction are shown in Appendix C.

Waste Management. The solid and liquid nonhazardous wastes generated during construction would include concrete and steel construction waste materials and sanitary wastewater. The steel construction waste would be recycled as scrap metal before construction was completed. The remaining nonhazardous wastes generated during construction would be disposed of by the contractor as part of the construction project. Uncontaminated

[18] The Department is developing ARIES to remove Pu from weapons pits and convert it into either an oxide or metal. This prototype program is intended to demonstrate a completely integrated process to disassemble and convert pits into an unclassified metal or oxide form that would be usable in the next disposition process facility.

wastewater would be used for soil compaction and dust control, and excavated soil would be used for grading and site preparation. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes such as adhesives, oils, and solvent rags would be packaged in DOT-approved containers and shipped to offsite commercial RCRA-permitted treatment, storage, and disposal facilities. No soil contaminated with hazardous or radioactive constituents is expected to be generated during construction. However, if any was generated, it would be managed in accordance with site practice and all Federal and State standards.

Operation of the pit disassembly and conversion facility would generate TRU, low-level, hazardous, mixed, and nonhazardous wastes. The conceptual design includes waste management facilities that would treat and package all waste generated into forms that would enable staging and/or disposal in accordance with RCRA and other applicable statutes. TRU and mixed TRU waste would be treated and packaged to meet the WIPP WAC. These wastes would be stored awaiting shipment to a Federal repository (assumed to be WIPP, depending on decisions resulting from the supplemental EIS for the proposed continued phased development of WIPP for disposal of TRU waste). LLW would be treated and packaged to meet the waste acceptance criteria of an onsite or offsite DOE LLW disposal facility. The DOE LLW disposal facility that would be used would be consistent with decisions resulting from the Waste Management PEIS and tiered NEPA documents. Mixed LLW would be treated and disposed in accordance with the respective site treatment plan that was developed to comply with the *Federal Facility Compliance Act*. Hazardous wastes would be packaged in DOT-approved containers and shipped to RCRA-permitted treatment and disposal facilities. Liquid nonhazardous wastes such as sanitary, utility, and process wastewater would be treated and discharged in accordance with the site practice. Treated wastewater would be reclaimed to use as makeup water when economically and/or environmentally desirable. Solid nonhazardous waste would be disposed of in permitted landfills and recycled, as appropriate. [Text deleted.]

Transportation. Intrasite transportation of all the receiving, storage, and processing activities would be contained within the facility. Transfers within the processing building would be through tunnels or secure transfer hallways. Material would be moved between process areas by carts, forklifts, or a conveyer system. Upon receipt, material would go either directly into the process lines or into lag storage, depending on the amount of material received and the status of the processing areas. After processing is complete, the material would be placed in lag storage before being sent to the next facility in the disposition process.

For offsite transfers, the organization initiating action for the material would have the ultimate responsibility for its safe transfer from the time the material is offered for transportation until it is received at the final destination. Shippers, transporters, and receivers are responsible for compliance with applicable transportation requirements. Destination of the products would depend on the disposition alternatives that are chosen. Transportation data can be found in Appendix G.

2.4.2 PLUTONIUM CONVERSION

For all the surplus Pu disposition alternatives, including the Preferred Alternative, Pu not processed at the pit disassembly/conversion facility would be processed at the Pu conversion facility. This facility would convert non-pit, surplus Pu into metal or oxide suitable for use at the next disposition facility in the process. Most, if not all, of the Pu material in the scope of the Storage and Disposition program is assumed to be in the *Criteria for Safe Storage of Plutonium Metal and Oxides* (DOE-STD-3013-94) stabilized form prior to disposition activities. However, a small amount of material consisting of metals, oxides, and alloys may need additional processing. Such materials would be converted in this facility for subsequent disposition. The facility would also provide lag storage for some materials to be converted. Figure 2.4.2–1 depicts the material flow through the facility.

In accordance with the Preferred Alternative for surplus Pu disposition, the Pu conversion facility could be located at either Hanford or SRS. Further tiered NEPA review will be conducted to examine alternative

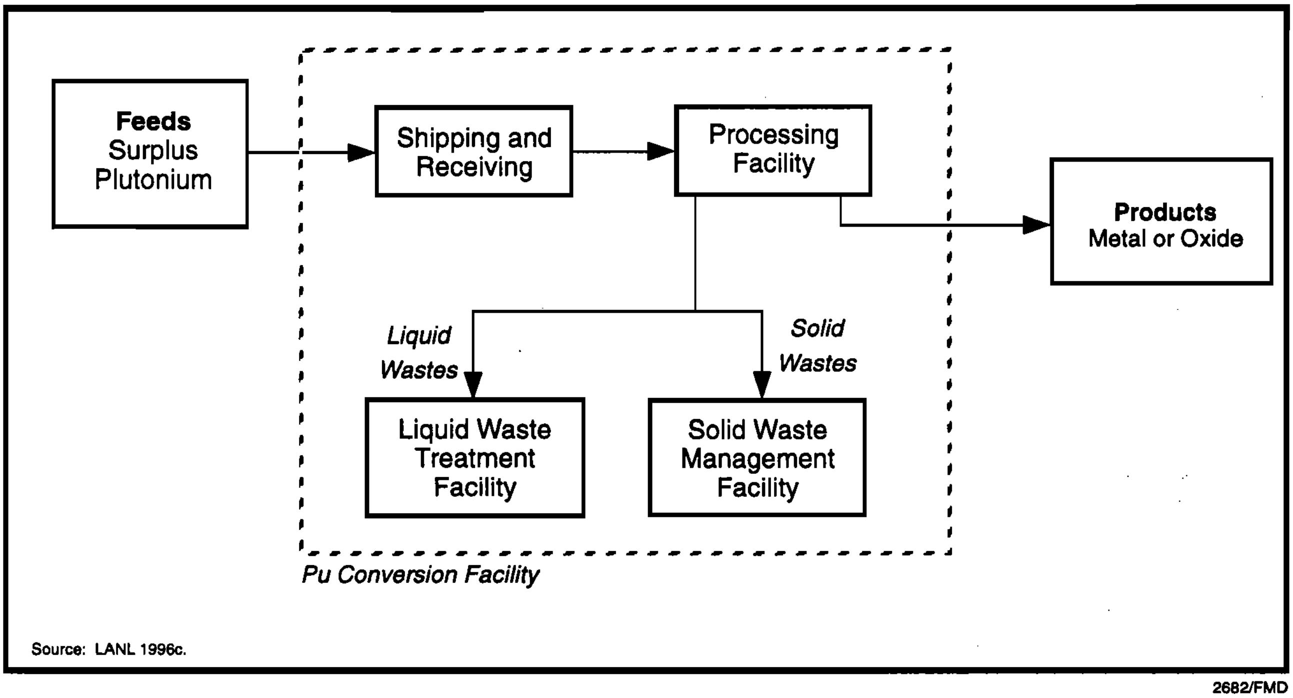

Figure 2.4.2–1. Plutonium Conversion Facility Material Flow Diagram.

locations, including new and existing facilities, at these two sites should the Preferred Alternative be selected at the ROD.

Facility Description. The material contained in the Pu conversion facility would require the highest levels of protection, including a 1.6-km (1-mi) buffer zone around the operating facility. Personnel security programs would require badging and access control of all personnel. For a new facility, the total disturbed land area would be approximately 28 ha (70 acres). Figure 2.4.2–2 depicts the conceptual site layout. Appendix B provides a more detailed description of key Pu conversion facility buildings. The mission of these buildings is as follows:

Central Warehouse, Shipping and Receiving Building. Packaging, safety confirmation of containers from the lag storage vault, and truck loading functions would be provided here. Services include unloading feed from transports, removing items from the shipping containers, confirming the contents, and handling abnormally sized packages.

Staging/Storage Facility. The interface between receiving and processing, and repackaging and storage functions would be provided in this building. These functions characterize, verify, and prepare the feeds and products for lag storage and control the flow and quality of material into and out of the glovebox operations.

Processing Building. Handling and processing Pu into a form acceptable for the next facility in the disposition process would occur here. This building would also provide utility support functions, MC&A, safety systems, waste management, repackaging, and assay and analysis.

Facility Operations. The Pu conversion facility conceptual design assumes that scrap and surplus Pu materials are pretreated to meet DOE interim storage and DOT shipping regulations. [Text deleted.] The facility design is flexible and provides for additional or reduced processing with minor process changes, such as increasing metal dissolution capacity for conversion to oxide, adding americium extraction, oxidation furnaces, or nitrate processing to meet additional alternative feed pretreatment requirements as feed forms and quantities are better defined. The Pu conversion facility would process Pu to a form that meets nuclear fuels feed or immobilization feed criteria. The facility design would be based on an annual throughput rate of 0.4 t (0.44 tons) of Pu, using one 10-hour shift, 200 days per year. Surge capability would be provided by increasing personnel and adding work shifts. Utilities and manpower resources needed during operations are presented in Appendix C. The water balance is depicted in Appendix D. Chemicals required during operations can be found in the Classified Appendix.

Construction. The construction of the Pu conversion facility would take approximately 6 years and have a peak annual employment of 358 construction workers. For a new facility, additional land area required temporarily for construction is projected to be approximately 8 ha (20 acres). This provides for construction material laydown, warehousing, and parking. Other resources consumed during construction are shown in Appendix C.

Waste Management. The solid and liquid nonhazardous wastes generated during construction would include concrete and steel construction waste materials and sanitary wastewater. The steel construction waste would be recycled as scrap metal before construction was completed. The remaining nonhazardous wastes generated during construction would be disposed of by the contractor as part of the construction project. Uncontaminated wastewater would be used for soil compaction and dust control, and excavated soil would be used for grading and site preparation. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes such as adhesives, oils, and solvent rags would be packaged in DOT-approved containers and shipped to offsite commercial RCRA-permitted treatment, storage, and disposal facilities. No soil contaminated with hazardous or radioactive constituents is expected to be generated during construction. However, if any were generated, it would be managed in accordance with site practice and all Federal and State standards.

Operation of the Pu conversion facility would generate TRU, low-level, hazardous, mixed, and nonhazardous wastes. The conceptual design includes waste management facilities that would treat and package all waste generated into forms that would enable staging and/or disposal in accordance with the RCRA and other applicable statutes. TRU and mixed TRU waste would be treated and packaged to meet the WIPP WAC. These wastes would be stored awaiting shipment to a Federal repository (assumed to be WIPP, depending on decisions resulting from the supplemental EIS for the proposed continued phased development of WIPP for disposal of TRU waste). LLW would be treated and packaged to meet the WAC of an onsite or offsite DOE LLW disposal facility. The DOE LLW disposal facility that would be used would be consistent with decisions resulting from the Waste Management PEIS and tiered NEPA documents. Mixed LLW would be treated and disposed in accordance with the respective site treatment plan which was developed to comply with the *Federal Facility Compliance Act*. Hazardous wastes would be packaged in DOT-approved containers and shipped to RCRA-permitted treatment and disposal facilities. Liquid nonhazardous wastes such as sanitary, utility, and process wastewater would be treated and discharged in accordance with the site practice. Treated wastewater would be reclaimed to use as makeup water when economically and/or environmentally desirable. Solid nonhazardous waste would be disposed of in permitted landfills and recycled, as appropriate.

Transportation. Intrasite transportation of radiological and hazardous materials would be between the Pu processing and manufacturing building and the Pu storage building. The storage container packages would be transported between vault storage and staging buildings via a hardened transfer corridor. Primary containers that have failed in storage or require intensive testing would be transported to Pu processing and manufacturing.

For offsite transfers, the organization initiating action for the material would have the ultimate responsibility for its safe transfer from the time the material is offered for transportation until it is received at the final destination. Shippers, transporters, and receivers would be responsible for compliance with applicable transportation requirements. Destination of the products would depend on the disposition alternatives that are chosen. Transportation data can be found in Appendix G.

2.4 PLUTONIUM DISPOSITION ALTERNATIVES AND RELATED ACTIVITIES

As described in Section 2.1.4, nine alternatives, which can be grouped into three categories, were identified as reasonable for disposition of Pu. The three categories and the alternatives within them are as follows:

Deep Borehole Category

- *Direct Disposition Alternative*—direct emplacement to deep boreholes without immobilizing Pu forms
- *Immobilized Disposition Alternative*—immobilization of Pu forms without adding radionuclides and then emplacement into deep boreholes

Immobilization Category

- *Vitrification Alternative*—immobilization of Pu in a glass matrix with processing in a vitrification facility and then dispose in a HLW repository[16]
- *Ceramic Immobilization Alternative*—immobilization of Pu in a ceramic matrix with processing in a ceramic immobilization facility and then dispose in a HLW repository[16]
- *Electrometallurgical Treatment Alternative*—immobilization of Pu in a GBZ form in an electrometallurgical treatment facility and then dispose in a HLW repository[16]

Reactor Category

- *Existing LWR Alternative*—convert Pu into MOX fuel, use MOX fuel in existing LWRs, and then dispose of spent fuel in an HLW repository[16]
- *Partially Completed LWR Alternative*—convert Pu into MOX fuel, use MOX fuel in partially completed LWRs, which are completed under this program, and then dispose of spent fuel in a HLW repository[16]
- *Evolutionary LWR Alternative*—convert Pu into MOX fuel, use MOX fuel in evolutionary LWRs, and then dispose of spent fuel in a HLW repository[16]
- *CANDU Reactor Alternative*—convert Pu into MOX fuel, use MOX fuel in Canadian CANDU reactors, and then dispose of spent fuel in the Canadian spent fuel program

Preferred Alternative for Pu Disposition: A combination of reactor and immobilization alternatives. The Preferred Alternative calls for (1) immobilizing at least those Pu materials not readily suitable for MOX fuel using vitrification or ceramic immobilization and (2) converting pure Pu metal, including pits, and oxides into MOX fuel for use in existing reactors. Use of Canadian CANDU reactors would be retained in the event that a multilateral agreement is made among Russia, Canada, and the United States to implement this.

The number of years a specific facility is expected to operate is based on facility sizing and throughput capacities. Preconstruction activities would require about 5 years for all the alternatives.[17] Preconstruction activities for the deep borehole category may take longer and may require additional legislation and associated

[16] See Appendix H (appropriate regulatory section) for a discussion of how the NWPA, as amended, might apply for disposal in a HLW repository.

[17] Preconstruction activities include tests, demonstrations, licenses, and tiered NEPA activities.

regulations. About another 5 years would be required for construction, startup, preoperational testing, and operational readiness review for all the alternatives. Construction of completely new reactors or deep boreholes could take longer. The time required for operations of all alternatives will vary depending on the amount of Pu material remaining after stabilization activities and the size, number, and throughput capacities of disposition facilities. If one of the domestic Reactor Alternatives were chosen, the MOX-based spent nuclear fuel is assumed to remain in the spent fuel pool for up to 10 years before relocation to a HLW repository. If either of the Deep Borehole Alternatives were chosen, the time to emplace the surplus Pu would depend on the number of deep boreholes being drilled. For each alternative, if decontamination and decommissioning (D&D) is proposed in the future, such activities are estimated to require up to 5 years for all but MOX fuel fabrication and reactors, which could take up to 10 years. D&D would not be proposed for the borehole sites, but for long-term institutional control (for future deterrence), the Deep Borehole Alternatives would likely take longer. D&D, if proposed, would be preceded by appropriate NEPA analysis.

As the various disposition technologies evolve and are refined through further study, development, and design, processes and facility arrangements would be optimized. This optimization would include specific operational relationships of facilities common to the selected alternatives, such as pit disassembly/conversion and Pu conversion facilities. Because this refinement process is ongoing, information and data presented in the technical documents for some of the alternatives are updated from that which was initially presented in the data reports supporting this PEIS. However, this PEIS considers the updated information as well. [Text deleted.]

Each of the nine disposition alternatives can be implemented in a number of ways because each alternative merely defines the generic technology approach used to achieve the Spent Fuel Standard. For example, using different numbers of existing reactors to accomplish the mission or utilizing different Pu concentrations within a borosilicate glass formulation represent variations for the existing reactor and vitrification alternatives, respectively. Determining which of the many possible variants to analyze within the PEIS is a matter of engineering judgment. A list of possible variants to the nine disposition alternatives is shown in Table 2.4–1.

[Text deleted.]

Representative facility locations for analyzing Pu disposition alternatives at Hanford, NTS, INEL, Pantex, ORR, and SRS are shown in Figures 2.4–1 through 2.4–6. These locations include those for the pit disassembly/conversion, Pu conversion, vitrification, ceramic immobilization, MOX fuel fabrication, and evolutionary LWR facilities. Locations for the deep borehole complex, commercial MOX fuel fabrication facility, and existing LWRs, are generic. At ORR, the representative site for the evolutionary LWR is on undeveloped land (see Figure 2.4–5). This site is not within the ORR boundary, but is owned by the Tennessee Valley Authority (TVA). A previous agreement between DOE and TVA has reserved the site for a nuclear application, and it is anticipated that the land area would be transferred from TVA to DOE. The Bellefonte Nuclear Plant, approximately halfway between Huntsville, Alabama, and Chattanooga, Tennessee, is the representative analysis site for the partially completed reactor alternative. INEL is the representative site for the Electrometallurgical Treatment Alternative. For the CANDU Reactor Alternative, the Bruce-A Nuclear Generating Station is the representative site for the analysis. The following sections describe the requirements for each disposition technology listed above.

[Text deleted.] Three Immobilization Alternatives and three reactor alternatives produce a waste form that could be suitable for disposal in a domestic HLW repository. Such a repository, if approved under the provisions of the NWPA and its amendments, would serve as the disposal site for commercial and DOE-owned spent nuclear fuel and HLW. DOE is currently characterizing the Yucca Mountain site for the repository. If the Secretary of Energy recommended the Yucca Mountain site for the repository, the recommendation would be accompanied by an EIS (the repository EIS), the NOI for which was published on August 7, 1995 (60 FR 40164). DOE completed scoping in Fiscal Year 1996 and will continue working the EIS given sufficient appropriations. The Yucca Mountain site has not yet been recommended by the President and approved by Congress; therefore, this Storage and Disposition PEIS does not analyze impacts to a repository. No waste forms are currently licensed for disposal

Table 2.4–1. Descriptions of Variants to Analyzed Disposition Alternatives

Alternatives	Possible Variants
• Deep borehole direct disposition	• Arrangement of Pu in different types of emplacement canisters.
• Deep borehole immobilized disposition	• Bucket emplacement of pellet-grout mix. • Pumped emplacement of pellet-grout mix. • Pu concentration loading, size and shape of ceramic pellets.
• New vitrification facilities	• Collocated pit disassembly, Pu conversion, and immobilization facilities. • Use of either Cs-137 from capsules or HLW as a radiation barrier. • Wet or dry feed preparation technologies. • An adjunct melter adjacent to the DWPF at SRS, in which borosilicate glass frit with Pu (without highly radioactive radionuclides) is added to borosilicate glass containing HLW from the DWPF. • A can-in-canister approach at SRS in which cans of Pu glass (without highly radioactive radionuclides) are placed in DWPF canisters which are then filled with borosilicate glass containing HLW in the DWPF (See Appendix O). • A can-in-canister approach similar to above but using new facilities.
• New ceramic immobilization facilities	• Collocated pit disassembly, Pu conversion, and immobilization facilities. • Use of either Cs-137 from capsules or HLW as a radiation barrier. • Wet or dry feed preparation technologies. • A can-in-canister approach at SRS in which the Pu is immobilized without highly radioactive radionuclides in a ceramic matrix and placed in which are then placed in the DWPF canisters that are then filled with borosilicate glass containing HLW (see Appendix O). • A can-in-canister approach similar to above but using new facilities.
• Electrometallurgical treatment (glass-bonded zeolite form)	• Immobilize Pu into metal ingot form. • Locate at DOE sites other than ANL-W at INEL.
• Existing LWR with new MOX facilities	• Pressurized or Boiling Water Reactors. • A different number of reactors. • European MOX fuel fabrication. • Modification/completion of existing facilities for MOX fuel fabrication. • Collocated pit disassembly/conversion, Pu conversion, and MOX fuel facilities. • Reactors with different core management schemes (Pu loadings, refueling intervals).
• Partially completed LWR with new MOX facilities	• Same as for existing LWR (except that MOX fuel would not be fabricated in Europe).
• Evolutionary LWR with new MOX facilities	• Same as for partially completed LWR.
• CANDU reactor with new MOX facilities	• A different number of reactors. • Modification/completion of existing facilities for MOX fabrication. • Collocated pit disassembly/conversion, Pu conversion, and MOX facilities. • Reactors with different core management schemes (Pu loadings, refueling intervals).

in a HLW repository. For the Immobilization Alternatives, legislative clarification or NRC determination by rule may be required before the immobilized Pu can be placed in an NWPA repository. Data to estimate waste forms under consideration in this PEIS for disposal in a repository are compared to data currently being evaluated for disposal in a NWPA-licensed repository. The results of this analysis are in Appendix H.

The fourth Reactor Alternative would use surplus U.S. Pu in MOX fuel for Canadian reactors, with the spent nuclear fuel managed by Canada. The MOX-based spent nuclear fuel from the alternative would be comparable to spent fuel from ongoing power producing operations in that country. This PEIS presents an analysis of domestic activities within the continental United States. A brief impact assessment of activities in Canada is included in Appendix I.

DOE would analyze the impacts of continued storage of immobilized Pu waste forms or MOX-based spent nuclear fuel in a tiered NEPA document under any of the following conditions: (1) if the DOE HLW Program changes its approach for disposal of commercial spent nuclear fuel, (2) if the timeframe for acceptance of waste by the program is significantly delayed beyond current projections, or (3) if the Pu immobilized waste forms or MOX-based spent nuclear fuel resulting from Pu disposition alternatives are not acceptable to a licensed repository.

Six DOE sites and other generic and specific sites were used for assessing the environmental impacts of various disposition technologies and strategies. The locations of the new facilities considered for the various disposition technologies are representative and for analysis purposes only. Until tiered NEPA documentation has been completed, no specific location within any specific site (or sites) will be selected for any disposition alternative action.

This Storage and Disposition PEIS assumes all surplus Pu could be processed through each of the various disposition technology alternatives. However, some surplus Pu material may not be suitable for processing under every disposition technology. As a result, the strategy for disposition of surplus Pu could involve a combination of disposition alternatives. In addition, if any of the LWR alternatives are selected, there is also a multipurpose reactor variant (see Section 1.4 and Appendix N) that could produce tritium, use Pu as fuel, and in some designs generate revenue through the sale of electricity.

No Plutonium Disposition Action

As discussed in Section 1.6, a "No Pu Disposition" action means disposition would not occur, and surplus Pu-bearing weapon components (pits) and other forms, such as metal and oxide, would remain in long-term storage in accordance with decisions on the long-term storage of Pu.

Activities Common to Multiple Plutonium Disposition Alternatives

As previously described, the disposition alternatives for surplus Pu involve a variety of technologies. However, two activities are common to all the disposition alternatives, including the Preferred Alternative:

- Pit disassembly/conversion
- Pu conversion

Since these common activities involve the conversion of surplus Pu from current forms to one suitable for disposition, they are essential components of each disposition alternative. Pit disassembly and Pu conversion facilities could be collocated. Multiple facilities located at the same site are analyzed in Section 4.7.3, and more specific analysis will be performed in tiered NEPA documents, as appropriate.

Upon completion of the pit disassembly/conversion and/or Pu conversion processes, the Pu materials would be ready for further actions under one or more of the disposition technology alternatives.

2.4.1 PIT DISASSEMBLY/CONVERSION FACILITY

The pit disassembly/conversion facility would be common to all disposition alternatives, including the Preferred Alternative. The facility would disassemble, reshape, and convert the pits into an unclassified metal or oxide form usable by the next facility in the disposition process. In addition, some non-pit material (such as pure Pu metal) may be processed at the pit disassembly/conversion facility. The material contained in the pit disassembly/conversion facility, would require the highest levels of protection.

In accordance with the Preferred Alternative for surplus Pu disposition, the pit disassembly/conversion facility could be located at either Hanford, INEL, Pantex, or SRS. Further tiered NEPA review will be conducted to examine alternative locations, including new and existing facilities, at these four sites should the Preferred Alternative be selected at the ROD.

Facility Description. The surplus Pu would be removed from the pits by separating them in half with a cutting wheel and subjecting each half to a dry chemical process that converts the metal to a hydride powder, then either back to metal or to an oxide powder. Figure 2.4.1–1 depicts the material flow through the facility.

The total disturbed land area for the operating facility would be approximately 12 hectares (ha) (30 acres), plus a 1.6-kilometer (km) (1-mile [mi]) buffer zone around the operating facility. Provisions would be included to accommodate future international treaty requirements for inspection. Figure 2.4.1–2 shows a conceptual site layout perspective.

[Text deleted.] Appendix B provides a more detailed breakdown of the key buildings required at the pit disassembly/conversion facility. These buildings and their missions include the following:

Plutonium Processing Building. Pits would be disassembled, and the Pu and other components would be separated in this building. All wastes would be processed here for disposal. In addition, the building would contain maintenance facilities, laboratories, utility systems, heating ventilation and air conditioning (HVAC) equipment, and other support functions.

Administration Building. Management offices, meeting and conference rooms, a visitor control office, and the cafeteria would be contained here.

Plutonium Operations Support Building. Change rooms, decontamination facilities, offices, maintenance shops, operator training rooms, process demonstration laboratories, and general storage areas would be located in this building.

Warehouse. This building would provide miscellaneous storage and general delivery areas.

Utilities Building. Steam and water treatment facilities, the plant air system, and the chilled water system would be located in this building.

Generator Building. Emergency generators would be located in this building.

Guard and Vehicle Monitoring Station. This building would serve as the pedestrian and vehicle entrance to the facility. A hardened guard booth and a vehicle entrance lane next to the pedestrian entrance would be provided.

Facility Operations. Wherever possible, operations would be conducted by automated and robotic systems to reduce personnel exposure. The facility would be designed for a throughput of 3.25 t (3.58 tons) of Pu per year, using two shifts per day, 5 days per week. Surge capability would be provided by increasing plant personnel and adding weekend work shifts.

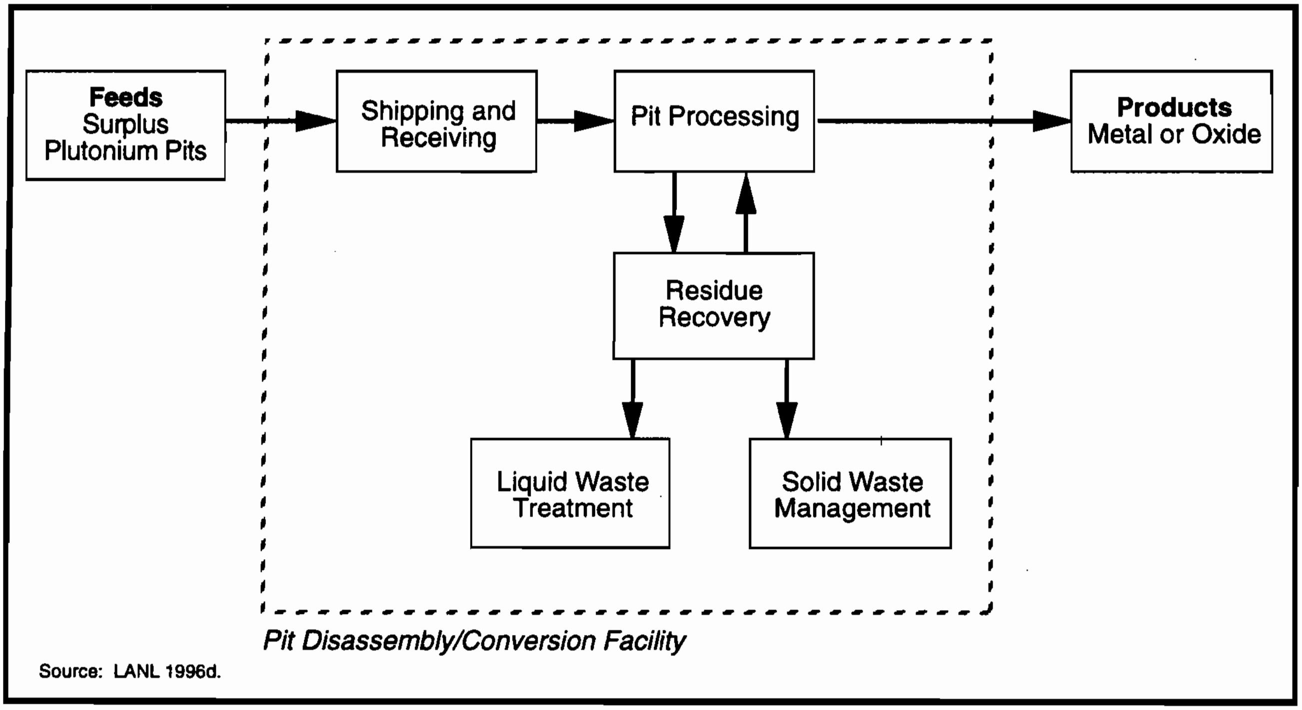

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Figure 2.4.1–1. Pit Disassembly/Conversion Facility Material Process Flow.

The pit disassembly/conversion facility would contain all required systems to remove Pu from weapons components and to package the material into an unclassified form suitable for shipment to the next facility in the disposition process. Operational flow within the facility would be through several main processing areas. Shipping and receiving would handle the incoming pit inspection, decontamination, storage, and initial processing and the outgoing shipping functions for the Pu metal or oxide produced by the facility. Pit disassembly and conversion operations[18] would process the pit mechanically and chemically within gloveboxes into either Pu metal or oxide (depending upon the selected disposition process) and would package it for removal. Another output of the process would be waste, both liquid and solid, consisting of low-level, TRU, hazardous, and mixed waste. An analytical laboratory would be required to perform Pu assays on product and waste streams as well as to certify waste streams. A lag storage vault would be used to store product metal or oxide, uranium forms, and other components before packaging for shipment to the next disposition facility. Utilities and manpower resources needed during operation are presented in Appendix C. Chemicals required during operations can be found in the classified appendix. The water balance is depicted in Appendix D.

Construction. Construction of the facility would take approximately 6 years and have a peak annual employment of 125 construction workers. Construction of the pit disassembly/conversion facility would require an additional 2 ha (5 acres) of land for construction laydown, warehousing, and construction parking. Resources consumed during construction are shown in Appendix C.

Waste Management. The solid and liquid nonhazardous wastes generated during construction would include concrete and steel construction waste materials and sanitary wastewater. The steel construction waste would be recycled as scrap metal before construction was completed. The remaining nonhazardous wastes generated during construction would be disposed of by the contractor as part of the construction project. Uncontaminated

[18] The Department is developing ARIES to remove Pu from weapons pits and convert it into either an oxide or metal. This prototype program is intended to demonstrate a completely integrated process to disassemble and convert pits into an unclassified metal or oxide form that would be usable in the next disposition process facility.

wastewater would be used for soil compaction and dust control, and excavated soil would be used for grading and site preparation. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes such as adhesives, oils, and solvent rags would be packaged in DOT-approved containers and shipped to offsite commercial RCRA-permitted treatment, storage, and disposal facilities. No soil contaminated with hazardous or radioactive constituents is expected to be generated during construction. However, if any was generated, it would be managed in accordance with site practice and all Federal and State standards.

Operation of the pit disassembly and conversion facility would generate TRU, low-level, hazardous, mixed, and nonhazardous wastes. The conceptual design includes waste management facilities that would treat and package all waste generated into forms that would enable staging and/or disposal in accordance with RCRA and other applicable statutes. TRU and mixed TRU waste would be treated and packaged to meet the WIPP WAC. These wastes would be stored awaiting shipment to a Federal repository (assumed to be WIPP, depending on decisions resulting from the supplemental EIS for the proposed continued phased development of WIPP for disposal of TRU waste). LLW would be treated and packaged to meet the waste acceptance criteria of an onsite or offsite DOE LLW disposal facility. The DOE LLW disposal facility that would be used would be consistent with decisions resulting from the Waste Management PEIS and tiered NEPA documents. Mixed LLW would be treated and disposed in accordance with the respective site treatment plan that was developed to comply with the *Federal Facility Compliance Act*. Hazardous wastes would be packaged in DOT-approved containers and shipped to RCRA-permitted treatment and disposal facilities. Liquid nonhazardous wastes such as sanitary, utility, and process wastewater would be treated and discharged in accordance with the site practice. Treated wastewater would be reclaimed to use as makeup water when economically and/or environmentally desirable. Solid nonhazardous waste would be disposed of in permitted landfills and recycled, as appropriate. [Text deleted.]

Transportation. Intrasite transportation of all the receiving, storage, and processing activities would be contained within the facility. Transfers within the processing building would be through tunnels or secure transfer hallways. Material would be moved between process areas by carts, forklifts, or a conveyer system. Upon receipt, material would go either directly into the process lines or into lag storage, depending on the amount of material received and the status of the processing areas. After processing is complete, the material would be placed in lag storage before being sent to the next facility in the disposition process.

For offsite transfers, the organization initiating action for the material would have the ultimate responsibility for its safe transfer from the time the material is offered for transportation until it is received at the final destination. Shippers, transporters, and receivers are responsible for compliance with applicable transportation requirements. Destination of the products would depend on the disposition alternatives that are chosen. Transportation data can be found in Appendix G.

2.4.2 PLUTONIUM CONVERSION

For all the surplus Pu disposition alternatives, including the Preferred Alternative, Pu not processed at the pit disassembly/conversion facility would be processed at the Pu conversion facility. This facility would convert non-pit, surplus Pu into metal or oxide suitable for use at the next disposition facility in the process. Most, if not all, of the Pu material in the scope of the Storage and Disposition program is assumed to be in the *Criteria for Safe Storage of Plutonium Metal and Oxides* (DOE-STD-3013-94) stabilized form prior to disposition activities. However, a small amount of material consisting of metals, oxides, and alloys may need additional processing. Such materials would be converted in this facility for subsequent disposition. The facility would also provide lag storage for some materials to be converted. Figure 2.4.2–1 depicts the material flow through the facility.

In accordance with the Preferred Alternative for surplus Pu disposition, the Pu conversion facility could be located at either Hanford or SRS. Further tiered NEPA review will be conducted to examine alternative

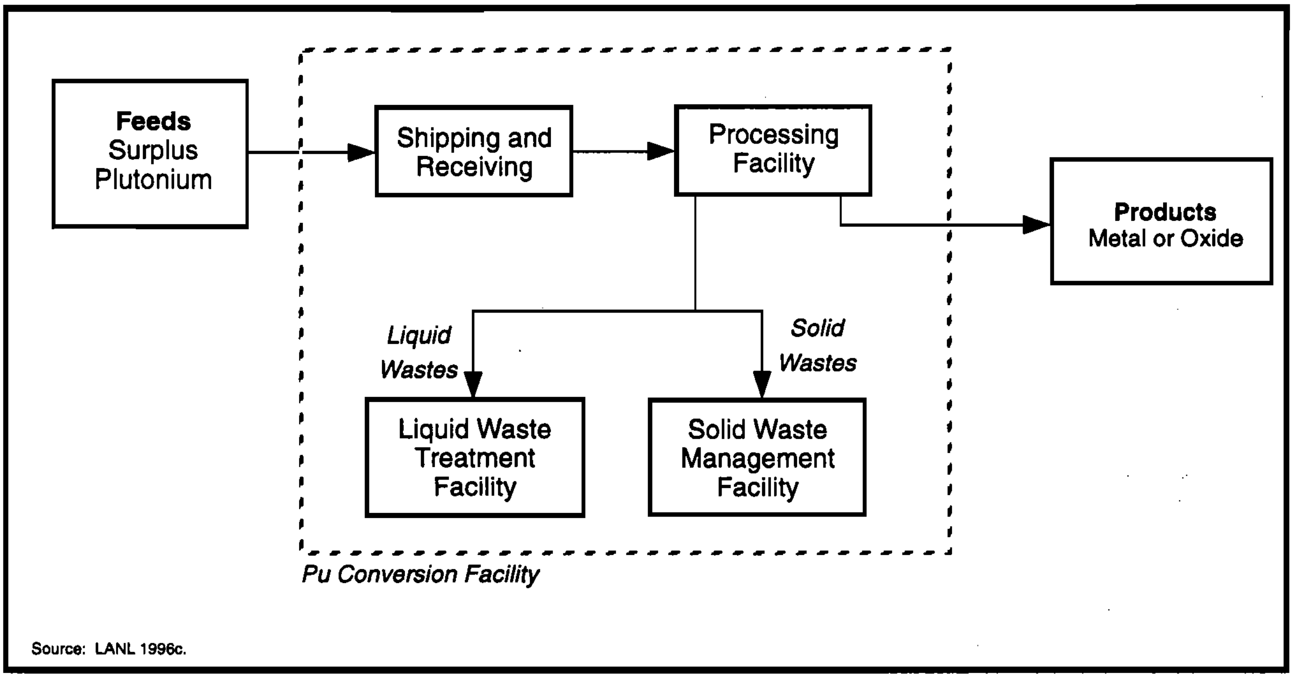

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Figure 2.4.2–1. Plutonium Conversion Facility Material Flow Diagram.

locations, including new and existing facilities, at these two sites should the Preferred Alternative be selected at the ROD.

Facility Description. The material contained in the Pu conversion facility would require the highest levels of protection, including a 1.6-km (1-mi) buffer zone around the operating facility. Personnel security programs would require badging and access control of all personnel. For a new facility, the total disturbed land area would be approximately 28 ha (70 acres). Figure 2.4.2–2 depicts the conceptual site layout. Appendix B provides a more detailed description of key Pu conversion facility buildings. The mission of these buildings is as follows:

Central Warehouse, Shipping and Receiving Building. Packaging, safety confirmation of containers from the lag storage vault, and truck loading functions would be provided here. Services include unloading feed from transports, removing items from the shipping containers, confirming the contents, and handling abnormally sized packages.

Staging/Storage Facility. The interface between receiving and processing, and repackaging and storage functions would be provided in this building. These functions characterize, verify, and prepare the feeds and products for lag storage and control the flow and quality of material into and out of the glovebox operations.

Processing Building. Handling and processing Pu into a form acceptable for the next facility in the disposition process would occur here. This building would also provide utility support functions, MC&A, safety systems, waste management, repackaging, and assay and analysis.

Facility Operations. The Pu conversion facility conceptual design assumes that scrap and surplus Pu materials are pretreated to meet DOE interim storage and DOT shipping regulations. [Text deleted.] The facility design is flexible and provides for additional or reduced processing with minor process changes, such as increasing metal dissolution capacity for conversion to oxide, adding americium extraction, oxidation furnaces, or nitrate processing to meet additional alternative feed pretreatment requirements as feed forms and quantities are better defined. The Pu conversion facility would process Pu to a form that meets nuclear fuels feed or immobilization feed criteria. The facility design would be based on an annual throughput rate of 0.4 t (0.44 tons) of Pu, using one 10-hour shift, 200 days per year. Surge capability would be provided by increasing personnel and adding work shifts. Utilities and manpower resources needed during operations are presented in Appendix C. The water balance is depicted in Appendix D. Chemicals required during operations can be found in the Classified Appendix.

Construction. The construction of the Pu conversion facility would take approximately 6 years and have a peak annual employment of 358 construction workers. For a new facility, additional land area required temporarily for construction is projected to be approximately 8 ha (20 acres). This provides for construction material laydown, warehousing, and parking. Other resources consumed during construction are shown in Appendix C.

Waste Management. The solid and liquid nonhazardous wastes generated during construction would include concrete and steel construction waste materials and sanitary wastewater. The steel construction waste would be recycled as scrap metal before construction was completed. The remaining nonhazardous wastes generated during construction would be disposed of by the contractor as part of the construction project. Uncontaminated wastewater would be used for soil compaction and dust control, and excavated soil would be used for grading and site preparation. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes such as adhesives, oils, and solvent rags would be packaged in DOT-approved containers and shipped to offsite commercial RCRA-permitted treatment, storage, and disposal facilities. No soil contaminated with hazardous or radioactive constituents is expected to be generated during construction. However, if any were generated, it would be managed in accordance with site practice and all Federal and State standards.

Operation of the Pu conversion facility would generate TRU, low-level, hazardous, mixed, and nonhazardous wastes. The conceptual design includes waste management facilities that would treat and package all waste generated into forms that would enable staging and/or disposal in accordance with the RCRA and other applicable statutes. TRU and mixed TRU waste would be treated and packaged to meet the WIPP WAC. These wastes would be stored awaiting shipment to a Federal repository (assumed to be WIPP, depending on decisions resulting from the supplemental EIS for the proposed continued phased development of WIPP for disposal of TRU waste). LLW would be treated and packaged to meet the WAC of an onsite or offsite DOE LLW disposal facility. The DOE LLW disposal facility that would be used would be consistent with decisions resulting from the Waste Management PEIS and tiered NEPA documents. Mixed LLW would be treated and disposed in accordance with the respective site treatment plan which was developed to comply with the *Federal Facility Compliance Act*. Hazardous wastes would be packaged in DOT-approved containers and shipped to RCRA-permitted treatment and disposal facilities. Liquid nonhazardous wastes such as sanitary, utility, and process wastewater would be treated and discharged in accordance with the site practice. Treated wastewater would be reclaimed to use as makeup water when economically and/or environmentally desirable. Solid nonhazardous waste would be disposed of in permitted landfills and recycled, as appropriate.

Transportation. Intrasite transportation of radiological and hazardous materials would be between the Pu processing and manufacturing building and the Pu storage building. The storage container packages would be transported between vault storage and staging buildings via a hardened transfer corridor. Primary containers that have failed in storage or require intensive testing would be transported to Pu processing and manufacturing.

For offsite transfers, the organization initiating action for the material would have the ultimate responsibility for its safe transfer from the time the material is offered for transportation until it is received at the final destination. Shippers, transporters, and receivers would be responsible for compliance with applicable transportation requirements. Destination of the products would depend on the disposition alternatives that are chosen. Transportation data can be found in Appendix G.

2.4.3 DEEP BOREHOLE CATEGORY

Under this category of alternatives, surplus weapons-usable Pu would be emplaced into one or more deep boreholes drilled below the water table into ancient, geologically stable rock formations. The Pu disposal form is emplaced and sealed in the emplacement zone, typically 2-km (1.25-mi) long. The isolation zone, also typically about 2-km (1.25-mi) long extends from the top of the emplacement zone to the ground surface, and would be filled and sealed with appropriate materials. At emplacement depths, which would be several kilometers greater than those of mined geologic repositories, the groundwater is expected to be stagnant. Because the barrier to transport posed by the isolation zone and the siting of the facility at a carefully selected stable location with stagnant groundwater at depth, the Pu is expected to remain, for all practical purposes, permanently isolated from the biosphere.

This PEIS analyzes two alternatives for emplacing Pu into a deep borehole: direct disposition and immobilized disposition. These are discussed in Sections 2.4.3.1 and 2.4.3.2, respectively. Under both alternatives, emplacement in a deep borehole would provide a geologic barrier to proliferation that would be difficult, costly, and time-consuming to overcome for recovering the material. According to the NAS, Pu in deep boreholes would be inaccessible to potential proliferators, but would be accessible to the state in control of the deep borehole site. Since the deep borehole is accessible to the nation in control of the deep borehole site, redrilling the hole could technically be accomplished within a few months. However, such activity would be detected well before the Pu was retrieved. As a result, it is doubtful that potential proliferators could recover the Pu or the host nation could recover the Pu without being detected. Therefore, under both alternatives, the Pu would not need to be mixed with HLW or other highly radioactive material to increase proliferation resistance. Under the first alternative, surplus Pu would be encapsulated directly in suitable canisters and emplaced into the deep borehole. Under the second alternative, surplus Pu would be converted into a ceramic pellet immobilized form. The ceramic pellets would then be mixed with grout and an equal volume of Pu-free ceramic pellets and emplaced into the deep borehole without canisters. Under either alternative, the deep borehole would be sealed after completion of the emplacement.

The environmental impacts of emplacement in a deep borehole are evaluated at a generic site that would be characteristic of a deep borehole complex. The identification of a suitable location for a deep borehole requires detailed site-specific studies and is beyond the programmatic scope of the Storage and Disposition PEIS. [Text deleted.] In addition, the regulatory requirements that the deep borehole must satisfy for site characterization and licensing for long-term disposal would have to be developed by the appropriate regulatory bodies.

2.4.3.1 Direct Disposition Alternative

Under this alternative, surplus Pu would be removed from storage, processed as necessary through the pit disassembly/conversion facility and/or the Pu conversion facility, packaged, and placed into a deep borehole. The deep borehole would be sealed to isolate the Pu from the accessible environment. The Direct Disposition Alternative does not require direct handling of dispersable Pu at the deep borehole site. Long-term performance of the deep borehole would depend on the stability of the geologic system to ensure isolation of Pu until rendered stable. No specific deep borehole locations have been identified but a generic assessment of site availability has been performed and site selection criteria have been developed (LANL 1996m:7-8, 27-38). This study has shown that suitable sites can be found in many regions of the continental United States. All requirements shown in this section are in addition to those previously stated for the pit disassembly/conversion and Pu conversion facilities.

Facility Description. Under the Direct Disposition Alternative, a deep borehole complex would be sited and constructed to dispose of surplus Pu material (Pu in various forms). Pu from the pit disassembly/conversion and Pu conversion facilities would be packaged to preclude criticality as determined by deep borehole disposal requirements. Two 2.25-kg (5-lb) product cans, a total of 4.5 kg (10 lb) of Pu, could be appropriately spaced inside each PCV. The PCV would be placed inside a shipping container (like a 6M) and shipped by SST to the deep borehole complex. The sealed PCVs would be removed from the shipping containers at the deep borehole complex and placed directly into metal emplacement canisters and sealed with kaolinite sealant, without any handling of dispersable Pu material. Emplacement canisters would be 0.4-m (16 in) in diameter, 6.1-m (20-ft) long, and contain 9 PCVs, which collectively contain 40.5 kg (89 lb) of Pu. Twenty-five emplacement canisters would be connected end-to-end in an emplacement string approximately 150-m (500-ft) long to facilitate faster canister insertion. A material flow diagram can be found in Figure 2.4.3.1–1.

The deep borehole subsurface facilities analyzed in this PEIS would consist of an array of four separate deep boreholes, with each deep borehole separated approximately 500 m (1,640 ft) from the nearest hole. Each deep borehole could be up to 4 km (2.5 mi) in depth. Figure 2.4.3.1–2 shows a typical deep borehole in which the upper 2 km (1.25 mi) or more of depth (the isolation zone) would pass completely through the water table and sedimentary and/or fractured crystalline rocks. The isolation portion of each borehole would be cased with steel pipe and filled and sealed with appropriate sealing materials to prevent influx and contamination of near surface waters. The lower 2 km (1.25 mi) would be drilled into crystalline basement rock that is isolated from the accessible environment. The emplacement zone of each borehole would contain 12 individual 150-m (500-ft) emplacement canister strings that would be grouted or cemented into place. Undercut seals would be installed between the canister strings in the emplacement zone for additional protection.

The deep borehole complex would occupy a land area of approximately 2,041 ha (5,043 acres), of which 57 ha (141 acres) would be occupied by the main facility and the assumed four-hole borehole array, with the remaining approximately 2,000 ha (4,940 acres) being buffer zone. Operations involving the Pu disposal form in the Surface Processing Facility are performed in an MAA that is hardened for security purposes. However, no direct contact with Pu is required. The MAA and facilities supporting MAA operations are located in a PA. The emplacement and borehole sealing facility to which the emplacement canisters are brought is also within a PA. Each PA is a secure, fenced area. The PA and operations involving any classified materials are contained within the LA. The PPA surrounds the LA and includes the buffer zone around the facility. The passenger vehicle parking and personnel services facilities are located outside the LA but within the PPA. A deep borehole facility site layout perspective is shown in Figure 2.4.3.1–3, and a list of deep borehole site buildings can be found in Appendix B.

The deep borehole complex would be designed to ensure that surface facilities could withstand earthquakes, high winds, or floods. The fire protection systems of the facility would be in accordance with DOE Orders and National Fire Protection Association Codes and Standards. The physical security, MC&A, IAEA safeguards, and physical security system facilities would be consistent with protecting Pu materials in the deep borehole complex surface facilities. In addition, the material would be emplaced to ensure post-emplacement downhole nuclear criticality safety.

The deep borehole complex would be a stand-alone site containing five types of facilities grouped by function. These five are described in the following:

Surface Processing Facilities. Surface processing facilities would receive the Pu metal and oxide disposal forms, provide lag storage of the received Pu materials, load emplacement canisters with the Pu metal and oxide disposal forms, and seal the canisters.

Drilling Facilities. Drilling rigs (either portable or constructed in place) would drill boreholes, seal natural and drilling-induced hydraulically conductive pathways in the host rock, install the casing in the isolation zone, and cement behind the casing to ensure a good hydraulic seal. Drilling facilities would mix various additives into the drilling mud and bring up brine from the bottom of the borehole as it is drilled. For this reason, each drilling facility would be provided with a wastewater treatment subsystem.

Emplacing-Borehole Sealing Facilities. One or more emplacing-borehole sealing facilities would emplace the Pu-bearing canisters, seal around the canister, and plug the upper 2-km (1.25-mi) isolation zone of the deep borehole. Workers would assemble canister modules into canister strings for emplacement at this subfacility. Under normal conditions, the water pumped from the borehole during emplacement operations would not be contaminated with radioactivity, and the wastewater would be treated as in any drilling operation. However, the water must continually be tested for radioactive contamination, and if contaminated, the water would be redirected to the main facility process wastewater treatment system. A containment structure covers the borehole entrance and emplacing equipment to contain any Pu that could be released in the event of an accident or canister breakage during emplacement.

Waste Management Facility. A waste management facility would treat the process wastes, process wastewater, utility wastewater, and sanitary wastewater generated by borehole disposal operations.

Support and Balance-of-Plant Facilities. A support facility would consist of administration, plant operations, and BOP. The BOP facilities would include security, plant alarm, safety and decontamination systems, shipping and receiving, central warehouse, maintenance, and utilities to provide general operational support.

Facility Operations. The borehole facility could process and dispose of 5 t (5.5 tons) of Pu, in all forms, each year. Operations would be based on continuous operations 7 days a week, 24 hours a day, in two 12-hour shifts with three drilling crews. A surge capacity of 10 t/year (yr) (11 tons/yr) could be achieved by introducing a second 8-hr shift in the surface processing and emplacing-borehole sealing facilities and by adding a second drilling rig and extra crews, as needed, in the drilling facility. Utility consumptions, chemicals consumed, and the number of personnel required during operations are listed in Appendix C.

The raw water requirement for the deep borehole disposal facility would be approximately 166 million liters (l) yr (44 million gallons [gal]/yr), of which 91 million l/yr (24 million gal/yr) would be consumed by the main facility area and the remainder consumed by the drilling and emplacing-borehole sealing facilities in the borehole array area. A raw water subsystem could be provided from production wells, supply pumps, and transfer piping to the facility water subsystem. The annual water balance for the borehole facility is shown in Appendix D.

Construction. Additional land area requirements during construction would be approximately 6 ha (15 acres) for construction laydown, warehousing, and temporary parking. The construction of the borehole complex would require 3 years and have a peak annual employment of 870 construction workers. Materials and resources consumed and employment needs during construction are listed in Appendix C.

Construction of the deep borehole array requires drilling several boreholes up to 4-km (2.5-mi) deep into geologically stable rock formations. This would be accomplished using drilling techniques based on technology developed for and used extensively in the petroleum, mining, and scientific drilling industries, and for deep boreholes drilled in crystalline rocks for disposal of HLW. The drill system would include a derrick to lower and raise the drillstring and bit and to route the slurry and cuttings. A slurry of water, compressed air, and bentonite additives would be pumped into the borehole to bring up cuttings. The used slurry then would be sent to a holding area to allow cutting solids to settle. The slurry would be filtered to remove coarser particles before it is recycled. When drilling holes down, two pipes, one inside the other, would be used. The fresh mud slurry would flow in the area between pipes (the annulus), and the cuttings would flow to the surface through the center pipe.

Boreholes would be drilled with their diameter decreasing with depth in a stepwise fashion, as dictated by site drilling conditions. A metal casing, smaller in outside diameter than the hole, would be inserted, and a cement slurry would be pumped at high pressure into the annulus between the casing and rock or soil in the isolation zone. Casing is not used in the emplacement zone. At specific locations in the borehole, the hole would be widened (undercut) to a larger diameter to provide a seat for seals and plugs. These seals and plugs, required to prevent vertical migration of fluids, would be installed during canister emplacement to achieve borehole closure.

A 3-year construction schedule is assumed for the deep borehole facility. The estimated total quantity of generated solid and liquid wastes associated with construction of the deep borehole disposal facility is shown in Appendix E. The waste generation data are based on factors from historic data on construction area size and construction labor force. Solid wastes would be hauled offsite for disposal during the construction period.

Waste Management. Waste management for the deep borehole complex would handle the treatment of criteria air pollutants, toxic and hazardous air emissions, and other gases emitted during operation and construction. Facility waste management would also include handling and treatment operations for processing TRU, low-level, and mixed waste, as well as industrial waste in aqueous, organic liquid, or solid forms generated from the onsite deep borehole disposition operations or from other site activities. Waste management would be in accordance with DOE Order 5820.2A and RCRA. TRU waste generated from deep borehole operations would be treated and packaged for disposal to WIPP (should DOE decide to operate WIPP for TRU disposal) in accordance with WIPP WAC (WIPP-DOE-069) and in accordance with decisions to be made as a result of the *Waste Isolation Pilot Plant Disposal Phase Supplemental Environmental Impact Statement*. A waste management process flow diagram is shown in Appendix E.

Estimated annual quantities of air pollutant emissions due to operation of the deep borehole disposal facility are shown in Appendix F. These emissions would result from minor borehole gases and fuel and gas consumption necessary to drill and, later, close the deep boreholes. Chemical processes that may lead to the release of contamination over time are unlikely in the abbreviated times associated with the canister emplacement, backfill, and closing processes. More likely are releases resulting from mechanical accidents where the containment canisters are breached.

Transportation. Intrasite transport of radiological materials will be limited to Pu metal and oxide container transport. There is no handling or processing of Pu on the site under normal operations. Intersite transportation of Pu material coming into the deep borehole facility from offsite would be in SSTs.

2.4.3.2 Immobilized Disposition Alternative

The second disposition alternative based on the deep borehole concept would immobilize surplus Pu in a ceramic spherical pellet form. Under this alternative, the output material from the pit disassembly/conversion and Pu conversion facilities would be sent to a ceramic immobilization facility. The ceramic immobilization facility would receive Pu feed in both oxide and metal forms. The output from the ceramic immobilization facility would be 2.54-centimeter (cm) (1-inch [in]) diameter coated ceramic pellets containing 1 percent by weight Pu. The ceramic pellets of Pu would be shipped by SST to the deep borehole facility. At the deep borehole facility the Pu-loaded ceramic pellets would be mixed with an equal volume of Pu-free commercially produced ceramic pellets and kaolinite clay grout and the mix would be directly emplaced in the borehole without any canisters. The drilling operations at the borehole facility would be similar to those described in the previous section. The emplacement of ceramic pellet-grout mix would be done either by bucket delivery or by pneumatically pumping slugs of the ceramic pellet-grout mix down a drill pipe. The sealing of the boreholes to isolate the emplaced Pu from the accessible environment would be as described in the previous section. Although representative locations for the ceramic immobilization facility are analyzed, no specific deep borehole locations have been considered. All requirements shown in this section, both for the ceramic immobilization facility and the deep borehole, are additive and are in addition to those requirements previously described for the pit disassembly/conversion and the Pu conversion facilities.

Facility description and operations, construction, waste management, and transportation descriptions for the ceramic immobilization facility are in the next section. They are followed by facility description and operations, construction, waste management, and transportation descriptions for the deep borehole complex.

2.4.3.2.1 *Ceramic Immobilization Facility—Immobilized Disposition Alternative*

Facility Description. A ceramic immobilization facility site of 18 ha (45 acres) would be required. The ceramic immobilization facility site layout is shown in Figure 2.4.3.2.1–1. The facility would be centered around a Pu processing facility and would contain waste processing and support facilities. The list of facilities is found in Appendix B. Support processes required at the immobilization facility would include radioactive liquid waste treatment, process offgas treatment, and waste solidification. Scrap recovery and Pu recycle, MC&A, cold chemical storage and makeup, process gas supply, material handling, equipment decontamination, and maintenance systems would also be required.

The ceramic immobilization facility would be designed to ensure that surface facilities could withstand earthquakes, high winds, and floods. The fire protection systems of the plant would be in accordance with DOE orders and National Fire Protection Association Codes and Standards. The material would be handled to ensure criticality safety. The physical security, materials control and accountability, IAEA safeguards, and physical security system facilities would be consistent with protecting DOE-defined Category I and II type special nuclear materials.

Facility Operations. Operations at the ceramic immobilization facility would process both Pu metal and oxide. The Pu metal would be oxidized, added to the material received as Pu oxide, and the oxides dissolved in an electrochemical solution consisting of nitric acid and silver nitrates. Plutonyl nitrate solution formed from the dissolution process would be mixed with ceramic additives called precursors. After sampling and feed adjustment, the solution would be calcined in a rotary calciner and converted to oxide powder. The powder would be fed into an anvil powder compacting press, which would compact the oxide powder to form green ceramic pellets. The pellets would be sintered at 1,200 degrees Celsius (°C) (2,200 degrees Fahrenheit [°F]) for about 8 hours. The resultant pellets would be spheres, about 2.54 cm (1 in) in diameter, and would contain about 1 percent Pu by weight. The pellets would contain Pu dispersed throughout the sphere, with an exterior coating of durable non-Pu-bearing ceramic material, and would be shipped to the deep borehole site via SST. The material flow through the ceramic immobilization process is shown in Figure 2.4.3.2.1–2.

The ceramic immobilization facility could process Pu metal and PuO_2 feed in the amount of 25 kg/day (55 lb day). Operations would be based on 3 shifts per day, 7 days per week, 24 hours per day. Normal plant availability is considered to be 200 days per year. The oxide dissolution rate is about 1.1 kg/hour (h) (2.4 lb/h). About 126 l (33 gal) of 200 g Pu/l (1.6 lb/gal) plutonyl nitrate solution is produced each day. Annual utility consumptions for the ceramic immobilization facility are listed in Appendix C, along with the chemicals consumed during ceramic immobilization operations and the number of personnel required during ceramic immobilization operations.

The raw water requirement for the ceramic immobilization facility would be approximately 322 million l/yr (85 million gal/yr). The annual water balance diagram for the ceramic immobilization facility is shown in Appendix D.

Construction. Additional land area requirements during construction of the ceramic immobilization facility would be approximately 28 ha (70 acres) of land for construction activities, laydown, and temporary parking. The construction of the ceramic immobilization facility would require 5 years and have a peak annual employment of 1,000 construction workers. Materials and resources consumed and employment needs during facility construction are listed in Appendix C. The peak construction year is based on the construction schedule. Estimated total quantities of solid and liquid wastes generated from activities associated with construction of new facilities are shown in Appendix E. [Text deleted.] Solid wastes would be hauled offsite for disposal during the construction period.

Waste Management. The ceramic immobilization facility would have its own facilities to control emissions of criteria pollutants, toxic and hazardous air pollutants, and other gases emitted during operation and construction.

Facility waste management would also include handling and treatment operations for processing TRU, low-level, and mixed wastes, as well as industrial waste in aqueous, organic liquid, or solid forms generated from onsite operations. Waste management would be in accordance with DOE Order 5820.2A and RCRA. TRU waste generated from operations would be disposed of at WIPP (should DOE decide to operate WIPP for TRU disposal) in accordance with WIPP WAC (WIPP-DOE 069) and in accordance with decisions to be made as a result of the *Waste Isolation Pilot Plant Disposal Phase Supplemental EIS*. The waste management process flow diagram and annual quantities of wastes expected to be generated during ceramic immobilization operations are shown in Appendix E. The estimated air emissions from the ceramic immobilization processes are shown in Appendix F.

Transportation. Intrasite transport of radiological materials at the ceramic immobilization facility would be limited to the transport of shipping containers of Pu metal and oxide into the processing facility and the shipping and handling of ceramic pellets containing Pu. Intersite transportation requirements exist for material coming into the ceramic immobilization facility from offsite and material being shipped from the ceramic immobilization facility to the deep borehole complex.

2.4.3.2.2 *Deep Borehole Complex—Immobilized Disposition Alternative*

Facility Description. The facilities required for disposal after immobilization are similar to those for direct disposition (Section 2.4.3.1), with minor exceptions in the receiving and storage facilities and an additional pellet-grout mixing facility and process waste management in the emplacing facilities. As explained in Section 2.4.3.1, subsurface facilities would consist of an array of four separate boreholes, with each deep borehole separated approximately 500 m (1,640 ft) from the next nearest hole. Each deep borehole would be about 4 km (2.5 mi) in depth. Figure 2.4.3.2.2–1 shows the cross-section of a typical deep borehole, in which the upper 2 km (1.25 mi) or more of depth would pass completely through the water table. The deepest 2 km (1.25 mi) would be drilled into crystalline basement rock that is isolated from the accessible environment.

The deep borehole complex would require approximately 2,041 ha (5,043 acres) and would include the same five groups of surface facilities with the subsurface borehole array as discussed in Section 2.4.3.1. The deep borehole site layout is shown in Figure 2.4.3.2.2–2.

The deep borehole facilities would be designed to ensure that surface facilities could withstand earthquakes, high winds, and floods. The fire protection systems of the site would be in accordance with DOE orders and National Fire Protection Association Codes and Standards. The physical security, materials control and accountability, IAEA safeguards, and physical security system facilities would be consistent with protecting DOE-defined Category I and II type special nuclear materials in the deep borehole complex above ground facilities. In addition, the material would be emplaced to ensure post-emplacement downhole criticality safety.

Facility Operations. The deep borehole complex would receive ceramic pellets of immobilized Pu from the ceramic immobilization facility. Material handling of the pellets would be accomplished at the borehole site, mixing ceramic pellets with grout before emplacement. No canisters would be required to emplace the ceramic pellets into the boreholes. This operation would be done without contamination risk or radiation hazard at the deep borehole site during normal operations. As in direct disposition, the containment structure located above the deep borehole entrance would contain any Pu releases if there were accidental breakage. The material flow through the deep borehole facility is shown in Figure 2.4.3.2.2–3.

The surface processing and emplacement/sealing facilities of the deep borehole complex would operate 5 days per week, 8 hours per day, 250 days per year. The drilling facility would operate 7 days per week, 24 hours per day in two 12-hour shifts with three drilling crews. The surge rate would be handled by introducing a second 8-hour shift in the surface processing and emplacement/sealing facilities and adding a second drilling rig and additional crew, if needed, in the drilling facility. Annual utility consumptions for the deep borehole operations are listed in Appendix C, along with the chemicals consumed and the number of personnel required during deep borehole operations. The annual water balance diagram for the deep borehole facility is shown in Appendix D. The raw water requirement for the deep borehole facility would be 138 million l/yr (36 million gal/yr).

Construction. Additional land area requirements during construction of the deep borehole complex would be 6 ha (15 acres) for construction laydown, warehousing, and temporary parking. The construction of the deep borehole facility would require 3 years and have a peak annual employment of 810 construction workers. Materials and resources consumed and employment needs during facility construction are listed in Appendix C. The peak construction year is based on the construction schedule. Estimated total quantities of solid and liquid wastes generated from activities associated with construction of new facilities are shown in Appendix E. [Text deleted.] Solid wastes would be hauled offsite for disposal during the construction period.

Waste Management. The deep borehole complex would have its own facilities to control emissions of criteria pollutants, toxic and hazardous air pollutants, and other gases emitted during operation and construction. Facility waste management would also include handling and treatment operations for processing industrial waste in aqueous, organic liquid, or solid forms generated from the onsite deep borehole operations or from other site activities. Waste management would be in accordance with DOE Order 5820.2A and RCRA. The waste management process flow diagram is shown in Appendix E as are the annual quantities of wastes expected to be generated during deep borehole operations. The estimated air emissions from the deep borehole operations are shown in Appendix F.

Transportation. Intrasite transport of radiological materials at the deep borehole would be limited to transport and handling of ceramic pellets. Intersite transportation requirements for radioactive material being shipped from the offsite ceramic immobilization facility to the deep borehole complex are shown in Section 4.4 (Table 4.4.2.2–1).

2.4.4 IMMOBILIZATION CATEGORY

Under this category of alternatives, surplus Pu would be immobilized in a subcritical matrix to create a chemically stable form for disposal in a HLW repository. The fissile material would be immobilized after mixing with radioactive isotopes from HLW or CsCl capsules to create a radiation field that could serve as a proliferation deterrent comparable to commercial spent nuclear fuel.

This PEIS analyzes the following three immobilization alternatives:

- Vitrification
- Ceramic immobilization
- Electrometallurgical treatment (GBZ form)

In addition, based upon comments from the public on the Draft PEIS there is substantial interest in the can-in-canister concept for the disposition of surplus Pu, and requests for DOE to consider its use. Accordingly, additional information on this concept is presented in Appendix O. The can-in-canister concept includes variations to the two Pu disposition alternatives for vitrification and ceramic immobilization. The can-in-canister concept could use modified existing facilities at SRS to perform the functions of the various pit disassembly/conversion, Pu conversion, and vitrification or ceramic immobilization facilities. For the vitrification can-in-canister approach, Pu would be immobilized in a glass matrix in small cans and the cans placed in stainless steel canisters which are then filled with molten HLW to serve as the radiation barrier. For the ceramic can-in-canister approach, Pu would be immobilized in a ceramic matrix in lieu of the borosilicate glass. In both cases, canisters would be filled at the DWPF and placed in lag storage at SRS until shipment to a HLW repository is possible.

2.4.4.1 Vitrification Alternative

Under this alternative, surplus Pu would be removed from storage, processed through the pit disassembly/conversion facility or the Pu conversion facility, packaged, and transported to the vitrification facility. The vitrification facility would be constructed or an existing facility would be modified, and the facility operated to accept surplus Pu in the form of metal and oxides. The Pu would be vitrified in borosilicate glass (or other types of glass) logs encased in stainless steel canisters. Also, HLW or the highly radioactive isotope Cs-137 would be mixed into the borosilicate glass to serve as a radiation barrier to theft and diversion. The Cs-137 isotope could be separated from CsCl capsules currently stored at Hanford. Gadolinium, hafnium, or another neutron absorber would be included along with the boron in the glass logs to prevent criticality. The borosilicate glass logs would be emplaced in a HLW repository (or alternative) for disposal. The absence of any RCRA-regulated hazardous materials in the final glass form would need to be demonstrated prior to acceptance into a HLW repository. The vitrified forms would remain in onsite vault-type lag storage, and would not be transported to a disposal site until such site is operational pursuant to separate appropriate NEPA documentation. A material flow diagram is presented in Figure 2.4.4.1–1. All requirements described in this section are in addition to those requirements previously described for the pit disassembly/conversion and the Pu conversion facilities.

Facility Description. The vitrification facility site layout for a new facility is shown in Figure 2.4.4.1–2. The facility data are found in Appendix B. The overall site would occupy approximately 12 ha (30 acres). All buildings would be located within a fenced area, with the Pu processing, radioactive waste management, and storage buildings contained within a PA. The mission of the key buildings in the vitrification facility follows.

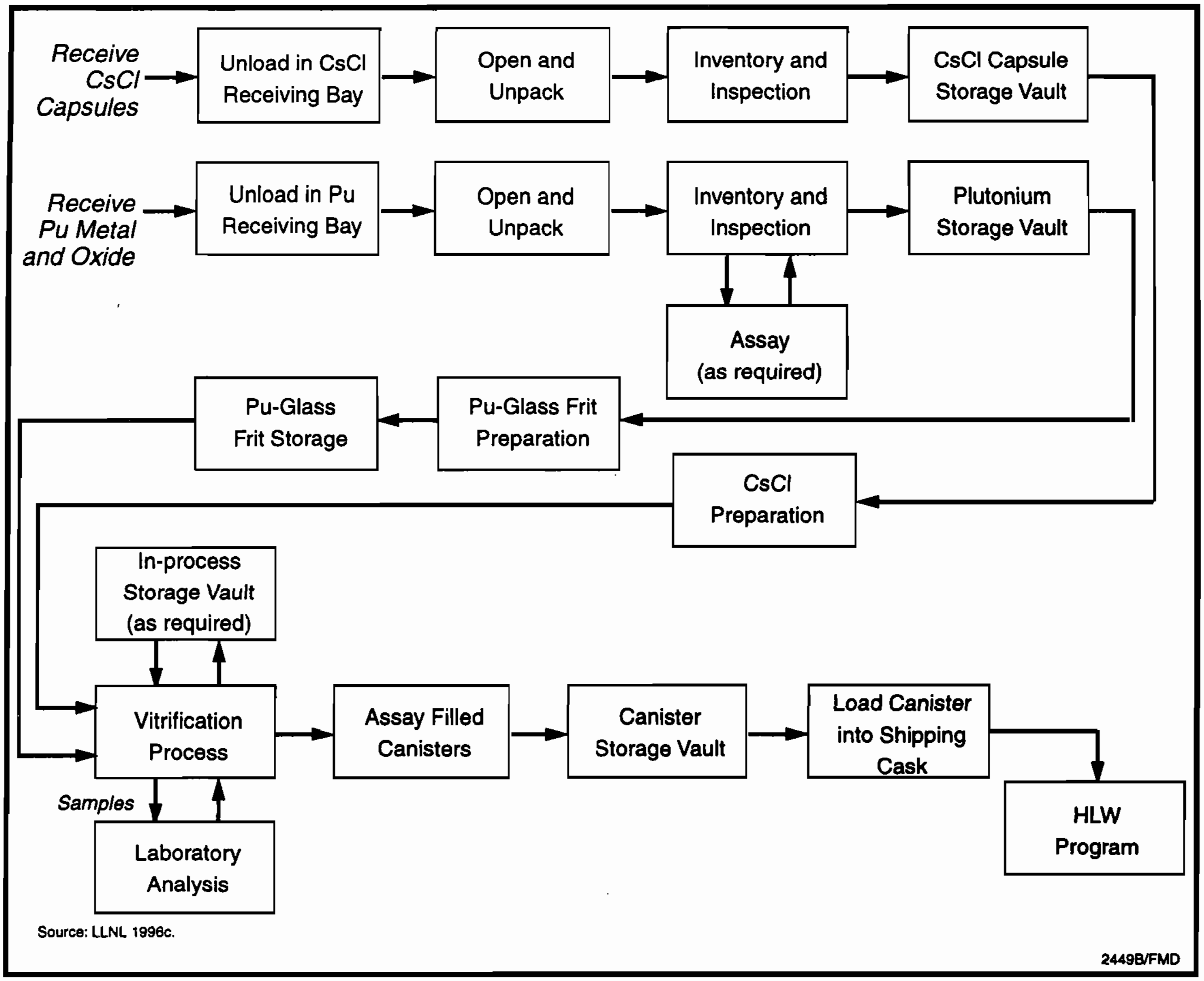

Figure 2.4.4.1–1. Vitrification Facility Material Flow Diagram.

Vitrification Building. The vitrification building would provide the following functions:

- Shipping, receipt, assay, and storage of all incoming radioactive process feed materials
- Accountability, repackaging, control, and temporary in-process remote storage of Pu, Cs, and other radioactive materials, and cold storage of chemical feed materials and borosilicate glass frit
- Conversion of incoming Pu metal and oxide to a borosilicate glass containing PuO_2 for subsequent inclusion within the vitrification process
- CsCl capsule and/or HLW processing and preparation for inclusion within the Pu-bearing borosilicate glass melt
- Processing of combined Cs-137/PuO_2 borosilicate glass melt
- Encapsulation, decontamination, and shipment of the combined Cs-137/PuO_2 borosilicate glass melt in a stainless steel cask to a repository (or alternative) for disposition

- Material accountability and temporary remote safe storage of completed and loaded casks awaiting transport to the repository or alternative

- Scrap treatment and recycle of recovered Pu and Cs for inclusion within the immobilization process

- Area access control, health physics, and personnel support

Service Building. The service building would provide the following functions:

- Central control for the main process and the crane

- Administrative support and office space, an analytical laboratory, training rooms, mock-up rooms, a lunchroom, change rooms, shops, an electrical equipment room, a utility equipment area, and warehousing

- Serve as the security access control point for the facility, providing regulated and nonregulated sections for radiation monitoring, decontamination, and access control

Interim Plutonium Canister Storage Vault. This building provides interim or lag storage after initial thermal cooling until shipment to a HLW repository.

Maintenance Building. This building would provide space for work on service vehicles and equipment that are too large for the service building.

Radwaste Building. This building would provide waste management for monitoring, treating, and handling liquid and solid radioactive wastes, industrial and chemical wastes, and sanitary/stormwater waste.

Chemical Storage Tank. This building would contain the nitric acid supply for washdown solution for decontaminating some of the process cells and equipment.

Cooling System. This building would provide cooling for water used in the immobilization process, air compressors, HVAC, and other process equipment.

Facility Operations. The vitrification facility would process surplus Pu into glass logs. A normal operating year would be 200 days. Nominal throughput in the vitrification facility would be 25 kg (55 lb) of Pu per operating day. The operating schedule assumes 3 shifts per day, 7 days per week. Time is allowed for remote maintenance, accountability, criticality control, and other functions that would shut down vitrification operations during the 165 days per year that the plant would not be expected to operate. Expected annual utility consumption, chemicals consumed, and the number of personnel required during operation are listed in Appendix C.

The raw water requirement for the vitrification facility would be approximately 250 million l/yr (66 million gal/yr). The annual water balance for the vitrification facility is provided in Appendix D.

The vitrification facility would be designed to ensure that facilities could withstand earthquakes, high winds, and floods. The fire protection systems of the plant would be in accordance with DOE Orders and National Fire Protection Association Codes and Standards. The physical security, materials control and accountability, IAEA safeguards, and physical security system facilities would be consistent with protecting DOE-defined Category I and II type special nuclear materials.

Construction. Additional land area requirements during construction would be approximately 12 ha (30 acres) for laydown areas, erosion control facilities, temporary utilities, and non-radioactive storage areas. The construction of the vitrification facility would require 5 years and have a peak annual employment of 382 construction workers. Materials and resources consumed and employment needs during construction are listed in Appendix C.

Estimated total quantities of solid and liquid wastes generated from activities associated with construction of the vitrification facility are shown in Appendix E. [Text deleted.] Solid wastes would be hauled offsite for disposal during the construction period. Waste management would be in accordance with DOE Order 5820.2A and RCRA.

Waste Management. The soil and liquid nonhazardous wastes generated during construction would include concrete and steel construction waste materials and sanitary wastewater. The steel construction waste would be recycled as scrap metal before construction was completed. The remaining nonhazardous wastes generated during construction would be disposed of by the construction contractor as part of the construction project. Uncontaminated wastewater could be used for soil compaction and dust control, and excavated soil would be used for grading and site preparation. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes such as adhesives, oils, and solvent rags would be packaged in DOT-approved containers and shipped to offsite commercial RCRA-permitted treatment, storage, and disposal facilities. No soil contaminated with hazardous or radioactive constituents is expected to be generated during construction. However, if any were generated, it would be managed in accordance with site practice and all Federal and State standards.

Operation of the vitrification facility would generate TRU, low-level, hazardous, mixed, and nonhazardous wastes. The conceptual design includes waste management facilities that would treat and package all waste generated into forms that would enable staging and disposal in accordance with RCRA and other applicable statutes. TRU and mixed TRU waste would be treated and packaged to meet the WIPP WAC. These wastes would be stored awaiting shipment to a Federal repository (assumed to be WIPP, depending on decisions resulting from the supplemental EIS being prepared for the proposed continued phased development of WIPP for disposal of TRU waste). LLW would be treated and packaged to meet the WAC of an onsite or offsite DOE LLW disposal facility. DOE LLW treatment, storage and disposal sites that would be used would be consistent with decisions resulting from the Waste Management PEIS and NEPA reviews tiered from that PEIS. Mixed LLW would be treated and disposed of in accordance with the respective site treatment plan developed to comply with the *Federal Facility Compliance Act* of 1992 and would be in accordance with decisions made pursuant to the Waste Management PEIS and tiered NEPA documents. Hazardous wastes would be packaged in DOT-approved containers and shipped offsite to RCRA-permitted treatment and disposal facilities. Liquid nonhazardous wastes such as sanitary, utility, and process wastewater would be treated, and either discharged in accordance with site practice or reclaimed to use as makeup water when economically and/or environmentally desirable. Solid nonhazardous waste would be disposed of in permitted landfills and recycled as appropriate. The vitrified Pu (with Cs or HLW) would be stored in the lag storage facility until shipment to and disposal in a HLW repository under the NWPA. Additional details can be found in Section E.3.2.4.

Transportation. Intrasite transport of radiological materials that are not vitrified would be limited to the secure transportation of shipping containers of Pu metal and oxide, and either CsCl capsules or HLW (via pipeline). Pu metal or oxide would be delivered from offsite by SST and transported to the Pu processing complex. Vitrified borosilicate glass logs encased in stainless steel canisters would be shipped from the vitrification building to onsite lag storage. The canisters would remain in lag storage until they are shipped by rail or truck from the vitrification facility to a HLW repository for disposal.

Modified Existing Facilities. As an example of a technology variant using modified existing facilities, the can-in-canister vitrification variant using the F canyon and DWPF at SRS is described in Appendix O.

2.4.4.2 Ceramic Immobilization Alternative

Under this alternative, surplus Pu would be removed from storage, processed through the pit disassembly/conversion facility or the Pu conversion facility, packaged, and transported to the ceramic immobilization facility. The ceramic immobilization facility would be constructed, or an existing facility would be modified, and the facility would be operated to accept surplus Pu in the form of metal and oxides. The Pu would be immobilized within a titanate-based ceramic matrix, formed into disks, and the disks would be encased in stainless steel canisters. Also, the highly radioactive isotope Cs-137, would be included into the ceramic matrix to serve as a radiation barrier to theft and diversion. The Cs-137 could be provided from CsCl capsules currently stored at Hanford or from HLW. Gadolinium, hafnium, or another neutron absorber also would be included in the ceramic matrix to prevent criticality. Canisters with the ceramic immobilized disks would be emplaced in a HLW repository (or alternative) for disposal. The absence of any RCRA-regulated hazardous materials in the final ceramic form would need to be demonstrated prior to acceptance into a HLW repository. The canisters would remain in onsite vault-type lag storage and would not be transported to a disposal site until the site is operational pursuant to separate appropriate NEPA documentation. A material flow diagram can be found in Figure 2.4.4.2–1. All requirements shown in this section are in addition to those requirements previously described for the pit disassembly/conversion and the Pu conversion facilities.

Facility Description. The ceramic immobilization facility site layout for a new facility is shown in Figure 2.4.4.2–2. The facility data is found in Appendix B. The overall site would occupy approximately 12 ha (30 acres). The primary Pu handling buildings would be located within a double security fenced area. The mission of key facilities follows.

Plutonium Processing Building. The Pu processing building would provide the following functions:

- Shipping, receiving, accountability, repackaging, control, and temporary in-process storage of Pu, Cs-137, and other radioactive materials, cold chemical feed materials, ceramic precursor, titanium metal, and bellows
- Processing, process control, decontamination, mechanical and electrical support, equipment maintenance, analytical laboratory analysis, and clean equipment maintenance
- Remotely operated ceramic immobilization processing and in-process storage of Pu and Cs
- Scrap treatment and recycling of Pu from contaminated process materials
- Area access control, health physics, and personnel support

Radwaste Management Building. This building would monitor, process, treat, and handle radioactive wastes, including low-level, TRU, and mixed wastes, in gaseous, liquid, and solid form.

Hot Maintenance Shop. This building would provide facilities for the maintenance and repair of process equipment from the Pu processing facility, the radiation waste management building, and the canister storage building. Shop areas are provided for receiving and decontaminating equipment, disassembly and repair of equipment, machining, repair of electrical equipment and controls, and equipment testing.

Canister Storage Building. This building would provide canister storage for 1 year of canister production and space for an additional 9 years capacity.

Facility Operations. The ceramic immobilization facility would process surplus Pu and Cs-137 into compressed ceramic bellows shaped like flat disks. Twenty ceramic bellows would be stacked inside stainless steel canisters which then would be sealed. A normal operating year would be 200 days. Nominal throughput in the ceramic immobilization facility would be 25 kg (55 lb) of Pu per operating day. The operating schedule assumes 3 shifts per day, 7 days per week. Time is allowed for remote maintenance, accountability, criticality control, and other functions that would shut down immobilization operations during the 165 days per year that the plant would not be expected to operate.

Expected annual utility consumption, chemical consumption, and personnel requirements during operation are listed in Appendix C. The raw water requirement for the ceramic immobilization facility would be approximately 250 million l/yr (66 million gal/yr). The annual water balance for the ceramic immobilization facility is shown in Appendix D.

The ceramic immobilization facility would be designed with features to prevent, control, and mitigate the consequences of potential accidents. The facility design uses a defense-in-depth approach to protect workers, the public, and the environment from release of radioactive or hazardous materials. Facilities would be designed to ensure that they would withstand earthquakes, high winds, or floods. The fire protection systems of the plant would be in accordance with DOE Orders and National Fire Protection Association Codes and Standards. The physical security, materials control and accountability, IAEA safeguards, and physical security system facilities would be consistent with protecting DOE-defined Category I and II type special nuclear materials.

Construction. Additional land area requirements during construction would be approximately 8 ha (20 acres) required for laydown areas, temporary utilities, and storage areas. The construction of the ceramic immobilization facility would require 5 years and have a peak annual employment of 1,000 construction workers. Projected material and resource consumption and employment needs during construction are listed in Appendix C.

Estimated total quantity of solid and liquid wastes generated during construction of the ceramic immobilization facility is shown in Appendix E. The waste generation data are based on factors from historic data on construction area size and construction labor force estimates. Solid wastes would be hauled offsite for disposal during the construction period. Waste management would be in accordance with DOE Order 5820.2A and RCRA.

Waste Management. The solid and liquid nonhazardous wastes generated during construction would include concrete and steel construction waste materials and sanitary wastewater. The steel construction waste would be recycled as scrap metal. The remaining nonhazardous wastes generated during construction would be disposed of by the contractor as part of the construction project. Uncontaminated wastewater could be used for soil compaction and dust control, and excavated soil would be used for grading and site preparation. Nonhazardous wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes such as adhesives, oils, and solvent rags would be packaged in DOT-approved containers and shipped to RCRA-permitted treatment, storage, and disposal facilities. No soil contaminated with hazardous or radioactive constituents is expected to be generated during construction. However, if any were generated, it would be managed in accordance with site practice and all Federal and State standards.

Operation of the ceramic immobilization facility would generate TRU, low-level, hazardous, mixed, and nonhazardous wastes. The conceptual design includes waste management facilities that would treat and package all waste generated into forms that would enable staging and disposal in accordance with RCRA and other applicable statutes. TRU and mixed TRU waste would be treated and packaged to meet the WIPP WAC. These wastes would be stored awaiting shipment to a Federal repository (assumed to be WIPP, depending on decisions resulting from the supplemental EIS for the proposed continued phased development of WIPP for disposal of TRU waste). LLW would be treated and packaged to meet the WAC of an onsite or offsite DOE LLW treatment, storage and disposal sites. DOE LLW treatment, storage and disposal sites that would be used would be consistent with decisions resulting from the Waste Management PEIS and NEPA reviews tiered from that PEIS. Mixed LLW would be treated and disposed of in accordance with the respective site treatment plan which was developed to comply with the *Federal Facility Compliance Act* and with decisions made pursuant to the Waste Management PEIS. Hazardous wastes would be packaged in DOT-approved containers and shipped to RCRA-permitted treatment and disposal facilities. Liquid nonhazardous wastes such as sanitary, utility, and process wastewater would be reclaimed to use as makeup water when economically and/or environmentally desirable. Solid nonhazardous waste would be disposed of in permitted landfills and recycled as appropriate. The immobilized Pu (with Cs or HLW) would be stored in the lag storage facility until shipment to and disposal in a HLW repository under the NWPA. Additional details can be found in Section E.3.2.5.

Transportation. Intrasite transport of radiological materials that are not immobilized would be limited to the secure transportation of shipping containers of Pu metal and oxide, and either CsCl capsules or HLW (via pipeline). Pu metal or oxide would be delivered from offsite by SST and transported to the Pu processing complex. Canisters, with immobilized Pu, would be transported intrasite to lag storage. The canisters would remain in lag storage until they are shipped by rail of truck from the ceramic immobilization facility to a HLW repository for disposal.

Modified Existing Facilities. As an example of a technology variant using modified existing facilities, the can-in-canister ceramic immobilization variant using the F canyon and DWPF at SRS is described in Appendix O.

2.4.4.3 Electrometallurgical Treatment Alternative

Under this alternative, surplus Pu would be removed from storage, processed through the pit disassembly/conversion facility or Pu conversion facility, packaged and transported to new or modified facilities for electrometallurgical treatment. The electrometallurgical treatment process could immobilize surplus fissile materials into two waste forms: a GBZ and/or a metal ingot. With the GBZ material, the Pu is in the form of a stable, leach-resistant mineral that is incorporated in durable glass materials. The processes to produce the metal waste form result in the larger accident impacts and are used as the basis for assessing potential accident consequences and risks. Although this alternative could be conducted at other DOE sites, the ANL-W site is described as being representative for analysis. If this alternative is selected at ROD, additional construction impacts could occur if implemented at a site other than ANL-W.[19]

With the electometallurgical treatment to immobilize the material into a GBZ form, Pu oxide or Pu would be converted to chlorides, dissolved in a molten salt solution, sorbed on zeolites, and then immobilized in a GBZ waste form. The Cs-137 isotope and HLW would be used to provide a radiation barrier. The Cs-137 isotope could come from processed CsCl capsules currently stored at Hanford. A material flow diagram is presented in Figure 2.4.4.3–1. The absence of any RCRA-regulated hazardous material in the final GBZ form would need to be demonstrated prior to acceptance into a HLW repository.

Facility Description. A facility site layout, using ANL-W as a representative site, showing the locations of the most relevant buildings is provided in Figure 2.4.4.3–2. The pertinent parameters for the major structures and other support buildings and areas, relevant to the immobilization activities, are detailed in Appendix B. A brief description of the primary facilities for this immobilization process (using ANL-W as a representative site) are as follows:

Fuel Cycle Facility (FCF) (Building No. 765). This area would house some of the major equipment that could be used in producing the GBZ waste form. This equipment would include an electrorefiner, a casting furnace,

[19] DOE has recently issued a FONSI (61FR25647) and decision to proceed with the demonstration of the electrometallurgical treatment process at ANL-W at INEL for processing up to 125 spent fuel assemblies from Experimental Breeder Reactor II (EBR-II) (100 driver and 25 blanket assemblies). The National Research Council performed *An Evaluation of the Electrometallurgical Approach for Treatment of Excess Weapons Plutonium,* (National Academy Press, Washington, D.C., 1996). The results of this evaluation will be considered in DOE's decisionmaking process for Pu disposition.

and a cathode processing system. The facility is composed of the FCF process building, the Safety Equipment Building, the interconnecting tunnel, the safety equipment pit, and exhaust gas stack.

Safety Equipment Building (No. 709). This building houses the safety-grade diesel generating and emergency exhaust systems.

Hot Fuel Examination Facility (HFEF) (No. 785). This facility contains hot cells for the remote handling of materials and may be used for the temporary storage of the product waste forms. The HFEF is capable of handling large, highly radioactive objects such as spent fuel elements from commercial light water reactors.

Zero Power Physics Reactor (No. 776) The cell and fuel storage vault would be used for temporary storage of incoming fissile materials. The facility is divided into an area under an earthen mound where all fissile materials would be stored and a support wing that contains rooms with monitoring and control instruments, offices and other support systems.

The reactor cell, which currently houses the ZPPR, is a 15.25-m (50-ft) diameter circular room with floor and walls of reinforced concrete. An air system that once provided cooling for the critical facility and maintained a negative pressure relative to the surroundings would be used to maintain a negative pressure in the two storage areas and provide cooling for product ingots with high gamma or neutron emissions. The analytical laboratory in this facility is fully equipped to support the immobilization activities.

Laboratory and Office Building (No. 752). This building contains analytical facilities and offices for the supporting technical and administrative personnel.

Fuel Manufacturing Facility (No. 704). This is a secure facility where glovebox facilities are located.

Radioactive Scrap and Waste Facility (No. 771). This facility provides temporary storage for radioactive and hazardous wastes. It is an RCRA Class B facility. The Radioactive Waste Management Complex (RWMC) at INEL is also available for interim waste storage.

ANL-W has in place, approved safeguard and security systems for the quantities of weapons-usable Pu materials to be located onsite. The site is equipped with a vehicle control station for positive control of all vehicular traffic to and from the ANL-W facilities that would be used for operations with surplus Pu-bearing materials.

Facility Operations. The Pu feed would consist of a combination of metal, oxides, and chloride salts. Immobilization operations would be performed 18 hours per day for 200 days per year. Nominal throughput in the electrometallurgical treatment facility would be 25 kg (55 lbs) Pu per operating day. The fissile materials would be shipped in and placed in lag storage at rates adequate to maintain the processing rate. Two to three months of inventories of feed materials would be stored onsite. The Pu loading in the GBZ waste form would be identified during the R&D program, but is estimated at 5 percent by weight of Pu. The package size is assumed to be up to 400 kg (880 lbs). Actual size would depend largely on criticality considerations. Neutron absorbers would be added to the waste form to decrease the probability of a criticality event.

During operation of the facility, only a minor increase in resources would be required to implement the Pu disposition mission since existing facilities, equipment, and personnel would be used. Additional personnel would be required to take care of operating the added equipment and to satisfy the increased security and safeguards requirements. The only additional utilities required would be electricity for the new process furnaces and a small increase in water consumption due to the increased number of employees and cooling requirements. The chemicals that would be consumed during operation include some process salt required for the material processed and some added zeolite and glass. Appendix C provides summary listings of the annual utilities, chemical resources, and employment operational requirements for this alternative.

No process water would be required. A modest increase in water would be required for a nominal 20-percent increase in the site population and cooling tower makeup water. A simplified water balance diagram is presented in Appendix D.

Construction. No new construction would be required to perform the immobilization operations with this alternative at ANL-W. The FCF was completely refurbished and upgraded in 1994 to modern standards appropriate for the immobilization project. Minor modifications would be expected to be required for the HFEF and ZPPR. The Pu immobilization effort would require additional equipment not currently in place in these facilities. Existing mock-up areas would be adequate for pre-installation checkout and qualification of this equipment, with the principal mock-up area located in the northeast corner of the FCF outside the MAA. The additional process equipment would be shipped in from offsite and installed in existing space. The materials and resources consumed and employment required during the modification period are given in Appendix C.

Waste Management. [Text deleted.] The Pu disposition mission would not significantly increase the quantity of liquid and solid wastes. The mass of the product HLW would be increased by the amount of Pu, zeolite, and Cs added. For the Pu disposition mission, the TRU, low-level, and other nonhazardous waste quantities would be in proportion to the processing rate. Due to operational controls to minimize the amount of hazardous materials used in conducting facility operations, the amount of mixed and hazardous wastes generated would be minimized. The amount of nonhazardous (sanitary) wastes would be based upon a water usage factor and the number of additional employees needed for the Pu disposition operations. An estimate of the annual waste volumes produced as a result of the disposition operations is presented in Appendix E. The radioactive emissions are conservatively based on the estimated releases from the FCF. Estimates of annual emissions during operations are provided in Appendix F. Waste facility modifications/construction would not be required to support the Pu disposition mission. Estimates of construction-related wastes and incremental operations emissions associated with this alternative are presented in Appendices E and F. Modifications to existing permits may be required to implement the Pu disposition mission.

Transportation. The periodic shipment of radioactive process feed materials and packaged waste products would be required to support the Pu disposition mission. Pu metal or oxide would be delivered by SST and stored in the ZPPR vault upon arrival at the site. Cesium feed would be shipped from Hanford as CsCl capsules and received and stored onsite in the HFEF.

When needed for processing, containers with the Pu feed would be transported to the FCF or HFEF process cell. Since the CsCl capsules would be stored at the HFEF, no intrasite transport of this material would be necessary. Following processing, the GBZ waste forms with the immobilized Pu would be placed in canisters for onsite lag storage until shipment to a HLW repository (or alternative) is possible.

2.4.5 Reactor Category and Common Activities

The alternatives under the Reactor Category considered in this PEIS would convert surplus Pu to MOX fuel for use in reactors. The irradiated MOX fuel would reduce the proliferation risks of the Pu material, and the reactors would generate electricity. The spent nuclear fuel generated from using the MOX fuel would be sent to an HLW repository or, if a foreign reactor is used, disposed of in a foreign spent fuel program.

These reactor alternatives include the following:

- Existing LWRs
- Partially Completed LWRs
- Evolutionary LWRs
- CANDU Reactors

Before surplus Pu can be used as reactor fuel, a conversion process is required to transform the Pu, in its various forms, into MOX fuel. The following common supporting facilities are required to process Pu, in its current forms, into MOX fuel:

- Pit disassembly/conversion facility
- Pu conversion facility
- MOX fuel fabrication facility

Under the various Reactor Alternatives, surplus Pu would be removed from storage, processed through the pit disassembly/conversion facility or Pu conversion facility, transported to the MOX fuel fabrication facility, converted into a MOX fuel, transported to the reactor site, and used as fuel for the reactor.

The Storage and Disposition PEIS addresses the disposition of surplus Pu. In the TSR PEIS (final version issued October 1995), there is an option for a multipurpose reactor that could produce tritium, use Pu in reactor fuel, and generate revenue through the production of electricity. Environmental analysis of the multipurpose reactor is included in the TSR PEIS. On December 6, 1995, the Secretary of Energy made the decision (60 FR 63878) that the future source of tritium would either be from a purchased reactor or irradiation in a commercial reactor or the accelerator production of tritium. The multipurpose reactor was preserved as an option for future consideration. DOE is also evaluating the operation of the FFTF at Hanford for its possible role as a multipurpose reactor in meeting future tritium requirements. Additional information can be found in Appendix N.

2.4.5.1 Mixed Oxide Fuel Fabrication

Mixed oxide fuel fabrication is common to all four reactor alternatives because each reactor would use Pu in the form of MOX fuel. In the 1970s, MOX fuel fabrication was conducted in a number of U.S. and foreign facilities on a laboratory or pilot line scale. However, today only the foreign MOX fuel fabrication programs continue. Proliferation concerns and unfavorable economics of Pu use resulted in a U.S. decision, in late 1970s, to defer indefinitely commercial reprocessing and recycling of the Pu produced in U.S. nuclear power programs. Consequently, MOX fuel fabrication facilities do not currently exist in the United States.

Converting surplus Pu into MOX fuel for use in a reactor would be consistent with U.S. nonproliferation policy since while the Pu is in the MOX fuel form it would be subject to high standards of safeguards and security and would be available for inspection by the IAEA. After use in a reactor, the Pu would meet the Spent Fuel Standard for proliferation resistance.

Because the United States does not have a MOX fuel fabrication facility or capability, a dedicated facility would likely have to be constructed or modified at a U.S. Government or existing commercial fuel fabricator's site. To provide MOX fuel until a domestic fuel fabrication plant is available, fuel for initial lead test assemblies and other MOX fuel may be produced by existing facilities in Europe on a short-term basis.

In accordance with the Preferred Alternative for surplus Pu disposition, the MOX fuel fabrication facility could be located at either Hanford, INEL, Pantex, or SRS. Further tiered NEPA review will be conducted to examine alternative locations, including new and existing facilities at these four sites, should the Preferred Alternative be selected at the ROD.

Facility Description. The MOX fuel fabrication facility would accept surplus Pu material in oxide form from the pit disassembly/conversion facility and the Pu conversion facility and fabricate mixed PuO_2-uranium dioxide (UO_2) fuel. The fabrication process would take PuO_2, purify it to meet MOX PuO_2 feed specifications, and blend it with UO_2 (this UO_2 may contain natural or depleted uranium) and any required burnable neutron absorbers. The MOX would be formed into pellets, loaded into fuel rods,[20] and assembled into fuel bundles. The facility would have storage capacity for approximately a 1-year supply of fuel bundles awaiting shipment to any of the various disposition reactors. Figure 2.4.5.1–1 presents a process flow diagram.

The total disturbed land area for the MOX fuel fabrication facility would be approximately 81 ha (200 acres), plus a 1.6-km (1-mi) wide buffer zone around the facility. All facility buildings would be located within a fenced area. A PA containing the fuel fabrication, waste management, receiving and storage, chemical storage, and cold support and utilities buildings would be surrounded by an appropriate perimeter security system. Within the PA, an MAA would connect the receiving and storage, fuel fabrication, and waste management buildings.

Figure 2.4.5.1–2 provides a facility site layout. The type of construction and the footprint area required for each building can be found in Appendix B. The mission description of these buildings follows.

Receiving and Storage Building. Process materials and supplies would be received and stored here. This building would house the Pu lag storage vault.

Fuel Fabrication Building. The MOX fuel fabrication processes would be housed here.

Waste Management Building. This building would process, temporarily store, ship, and provide control and accountability for all solid, liquid, contaminated, or uncontaminated generated wastes. The waste processes and handling areas would be segregated by waste form.

Cold Support and Utilities Building. This building would house HVAC, electrical, water, and natural gas distribution for the facility. It would also provide a machine shop and storage facilities for nonradioactive or uncontaminated materials.

General Administration and Security Building. This building would provide office and support space for the site.

Fire Station. This building would provide augmented support to the site (in addition to local services) for immediate response to fire and medical emergencies.

Chemical Storage Area. This area would provide space for chemical storage tanks that supply the buildings and processes in the PA.

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[20] The term "rods" used herein means LWR rods or CANDU elements.

Utilities Area. This area would be the entrance and metering point for electrical, natural gas, and water supplies. The electrical substation, emergency generator(s), and associated switching equipment would be located in this area.

Facility Operations. Initial operations would begin 1 year before associated reactor operations using the MOX fuel. Based on these data, a campaign for the disposition of surplus Pu can be examined. As shown in Table 2.4.5.1–1, a Pu throughput of between 2.9 t/yr (3.2 tons/yr) and 5.0 t/yr (5.5 tons/yr) would be achievable. The average fraction of input weapons-grade Pu would determine the throughput required of the fuel fabrication facility and, consequently, facility size and environmental impact. The MOX fuel Pu fraction would range, depending on reactor type, between 2.2 and 6.8 percent of the heavy metal (uranium and Pu). Required throughput, depending on reactor type, would range between 52 t/yr (57 tons/yr) and 150 t/yr (165 tons/yr) heavy metal. Therefore, nominal MOX throughput would be 50 t/yr (55 tons/yr) heavy metal, and the bounding MOX throughput would be 150 t/yr (165 tons/yr) heavy metal. Expected annual utility consumption for facility operation, annual chemicals consumed during operation, and the number of personnel required during operation are provided in Appendix C.

Protection of special nuclear material requires an integrated program involving both material control and accountability. Safeguards and security systems would be designed to meet DOE, NRC, and, as applicable, IAEA requirements.

Estimated annual emissions released from the MOX fuel fabrication facility during operations are listed in Appendix F. These emissions would be made up of various gases used or otherwise generated as a result of activities involved in MOX fuel fabrication. All gaseous effluent streams coming from the facility would be thoroughly scrubbed or filtered to remove or reduce the amount of undesirable particulates before release. Estimates of annual wastes resulting from the MOX fuel fabrication facility are shown in Appendix E. No HLW would be generated during normal operations. A diagram of the water balance for the new MOX fuel fabrication facility is presented in Appendix D.

Construction. The construction of the MOX facility would require 6 years and have a peak annual employment of 475 construction workers. The primary constraint on this schedule is the coincident operation of the MOX fuel fabrication facility with that of the two to five dispositioning reactors and the availability of the PuO_2 stock. Additional land area required for construction is projected to be approximately 40 ha (99 acres). This provides

Table 2.4.5.1–1. Mixed Oxide Fuel Reactors Operations Assumptions

Reactor Type (3 to 5 LWRs required)	Average MOX Enrichment of Pu in Heavy Metal (percent)	Pu Throughput (t/yr)	MOX Throughput (t/yr of heavy metal)
Existing			
BWR-full MOX	3.0	3.0	98.8
PWR-full MOX	4.2	5.0	118.2
CANDU-reference MOX[a]	2.2	2.9	136.1
CANDU-CANFLEX MOX[a]	3.4	5.0	149.9
Evolutionary			
Large	6.8	3.5	52.2
Small	6.6	4.1	61.4

[a] CANDU-reference MOX utilizes a standard fuel bundle, whereas the CANFLEX-MOX option uses an alternate fuel design that would permit the use of higher Pu concentrations and result in a higher burn-up of the MOX fuel.

Source: DOE 1996o; LANL 1996b.

for construction material laydown, warehousing, and temporary parking. Materials and resources consumed during construction of a new facility, and the number of construction personnel required, are presented in Appendix C. Total amounts of solid and liquid wastes generated during construction are given in Appendix E.

Waste Management. The solid and liquid nonhazardous wastes generated during construction would include concrete and steel construction waste materials and sanitary wastewater. The steel construction waste would be recycled as scrap metal before construction was completed. The remaining nonhazardous wastes generated during construction would be disposed of by the contractor as part of the construction project. Uncontaminated wastewater would be used for soil compaction and dust control, and excavated soil would be used for grading and site preparation. Non-hazardous wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes such as adhesives, oils, and solvent rags would be packaged in DOT-approved containers and shipped to offsite commercial RCRA-permitted treatment, storage, and disposal facilities. No soil contaminated with hazardous or radioactive constituents is expected to be generated during construction. However, if any were generated, it would be managed in accordance with site practice and all Federal and State standards.

Operation of a new MOX fuel fabrication facility would generate TRU, low-level, hazardous, mixed, and nonhazardous wastes. The conceptual design includes waste management facilities that would treat and package all waste generated into forms that would enable staging and disposal in accordance with RCRA and other applicable statutes. TRU and mixed TRU waste would be treated and packaged to meet the WIPP WAC. These wastes would be stored awaiting shipment to a Federal repository (assumed to be WIPP, depending on decisions resulting from the supplemental EIS for the proposed continued phased development of WIPP for disposal of TRU waste). LLW would be treated and packaged to meet the WAC of an onsite or offsite LLW disposal facility. The LLW treatment/disposal facilities that would be used would be consistent with decisions resulting from the Waste Management PEIS and NEPA reviews tiered from that PEIS. Mixed LLW would be treated and disposed of in accordance with the respective site treatment plan which was developed to comply with the *Federal Facility Compliance Act* of 1992, if applicable, and with decisions made pursuant to the Waste Management PEIS and tiered NEPA reviews, if applicable. Hazardous wastes would be packaged in DOT-approved containers and shipped to RCRA-permitted treatment and disposal facilities. Liquid nonhazardous wastes, such as sanitary, utility, and process wastewater, would be treated and discharged in accordance with the site practice or reclaimed to use as makeup water when economically and/or environmentally desirable. Solid nonhazardous waste would be disposed of in permitted landfills and recycled as appropriate. Additional details can found in Section E.3.2.3.

Transportation. Transportation of Pu and associated wastes would be subject to government regulations and DOE Orders regarding safety and security. The facility would receive PuO_2 and send out completed MOX fuel bundles. Intersite shipment of Pu-bearing material would be by SST to minimize potential for diversion. For domestic MOX fuel fabrication, UO_2 feed stock would come from existing domestic commercial sources and would be shipped by approved commercial carriers. UO_2 feed stock for European MOX fuel fabrication would come from existing European sources. Appendix G presents intersite transportation data for input and output materials.

European Mixed Oxide Fuel Fabrication Facility. MOX fuel could be produced in existing European MOX fuel fabrication facilities. However, studies have shown that the Europeans are driving their MOX fuel fabrication capacity and projected MOX fuel demand towards a balance (DOE 1995c:1-7). In the near-term, European MOX fuel fabricators have excess capacity that could be applied to support weapons-Pu disposition. This excess capacity could support fabrication of lead test assemblies and possibly partial reloads or a few reload full cores. While the Europeans may be willing to expand their capacity to support surplus weapons-Pu disposition, the United States would likely have to pay a premium for such MOX fuel. In addition, because European MOX capacities and demand could unexpectedly change, resulting in the loss or gain of excess capacity, until contracts are signed for the fabrication of fuel from U.S. surplus-weapons Pu, the United States should not rely on excess European MOX fabrication capacity in the long term. Transportation risks associated with moving the Pu feed materials and the finished MOX fuel across the global commons are presented in Appendix G.

2.4.5.2 Existing Light Water Reactor Alternative

Under this alternative, surplus Pu would be removed from storage, processed through the pit disassembly/ conversion facility or the Pu conversion facility, packaged, transported to a MOX fuel fabrication facility, and converted to MOX fuel. The finished MOX fuel would be transported to three to five existing LWRs for use in lieu of conventional uranium reactor fuel. The reactors employed for domestic electric power generation are conventional LWRs that use water as a moderator and coolant. The two types of LWRs used are pressurized water reactors (PWRs) and boiling water reactors (BWRs). Approximately two-thirds of the operating power reactors in the United States are PWRs.

In accordance with the Preferred Alternative for surplus Pu disposition, three to five existing LWRs could be selected. This would occur only after negotiations between DOE and interested parties, and through a competitive procurement process. Further tiered NEPA review will be conducted to examine locations (as many as five sites or as few as one site) should the Preferred Alternative be selected at the ROD.

Facility Description. A sample of reactors from across the United States was compiled in order to generate generic operating characteristics for a commercial LWR, since no specific site or reactor has been selected. The sample was studied to determine valid, applicable characteristics that could be used to describe a generic reactor using MOX fuel. The sample includes eight operating high power (greater than 1,200 megawatt electric [MWe]) PWRs and four BWRs built after 1975. Characteristics of these 12 were felt to be representative of both reactor types, since none of the 12 experienced any unusual operating conditions over the operating period reviewed. Where possible, data was averaged for the 5-year period to smooth out unusually low or high values due to shutdowns for reasons other than normal refueling or maintenance activities.

Data for each reactor characteristic were taken for calendar years 1988 to 1992 (ORNL 1995b:A-5). Entries for all 12 plants were used to determine an average for each listed characteristic.

Nuclear power plants generally contain the four major components described below. Figure 2.4.5.2–1 depicts a typical LWR facility.

Reactor Building. This building houses the reactor vessel, the suppression pool (BWRs only), steam generators and pressurizers (PWRs only), pumps, and associated piping. BWRs generate steam directly within the reactor core and pass it through internal moisture separators and steam dryers before sending it to the turbine. In contrast, PWR reactor heat is transferred from the primary coolant to a secondary coolant loop that is at a lower pressure. Generated steam from the secondary loop then flows to the turbine.

All domestic nuclear power plants have containment structures as a major safety feature to prevent release of radionuclides in the event of an accident. BWR containments are composed of a suppression pool and dry well. PWRs have one of three types of containments structured: large, dry; subatmospheric; or ice condenser. Large, dry containments comprise approximately 80 percent of the PWR containment structures.

Turbine Building. This building houses the steam turbine and generator, condenser, waste heat rejection system, pumps, and equipment that support these systems.

Auxiliary Buildings. These buildings house support systems such as the ventilation system, emergency core cooling system, water treatment system, waste treatment system, fuel storage facilities, and plant control room. Also, the plant site contains a large switchyard.

Cooling Towers and Ponds. Water is used predominantly for cooling in nuclear power plants, and accordingly these facilities are designed to remove excess heat without dumping this heat directly into adjacent water bodies. The quantity of water used is a function of several factors, including the capacity rating of the plant and the increase in cooling water temperature from intake to discharge. Therefore, the larger the plant, the greater the quantity of waste heat to be dissipated and the greater the quantity of cooling water required. In addition, the quantity of water used is a function of the type of cooling system.

Approximately half of the operating power reactors use "closed-cycle" cooling systems as opposed to "once-through" cooling systems. In closed-cycle systems, waste heat is removed by dissipation to the atmosphere, usually through cooling towers. Several types of closed-cycle cooling systems are currently in use. These systems consist of either natural or mechanical draft cooling towers, cooling ponds, cooling lakes, or cooling canals. Most of the water used for cooling is not returned to a water source because the predominant cooling mechanism associated with closed-cycle systems is evaporation.

In addition to removing waste heat, closed-cycle systems provide cooling for service water and auxiliary cooling water systems. At closed-cycle cooling sites, the additional water needed for source water and auxiliary cooling water systems is usually less than 5 percent per year of that needed for waste heat cooling.

In a once-through cooling system, circulating water is drawn from an adjacent body of water (such as a lake), passed through cooling tubes, and returned to the same body of water at a higher temperature. The volume of water required for service and auxiliary systems is usually less than 15 percent of the volume required for waste heat cooling at once-through cooling sites. Some systems are augmented with helper cooling towers that reduce the temperature of the water released. Waste heat is then dissipated in the receiving water body.

The water intake and discharge structures accommodate the source water body and minimize impacts to the aquatic ecosystem in both cooling systems. The intake structures are generally located along the shoreline of the body of water and equipped with fish protection devices. The discharge structures are generally of the jet or diffuser outfall type and are designed to promote rapid mixing of the effluent stream with the receiving body of water. Chemicals used for corrosion control and other water treatment purposes are also mixed with the cooling water and then discharged from the system.

Some nuclear power plants use groundwater as a source of makeup or potable water in addition to surface water sources. Other existing LWR sites operate dewatering systems that intentionally lower the groundwater table in the vicinity of building foundations either through pumping or a system of drains.

Facility Operations. Three to five existing LWRs would be operated to achieve 3 to 5 t/yr (3.3 to 5.5 tons/yr) throughput for disposition of surplus Pu and simultaneous production of electric power. No attempt was made to characterize the optimum reactor deployment approach. The data presented and analyzed in this PEIS is representative of reactor operations using full MOX fuel cores. The actual core loading for individual reactors will be determined as part of business decisions that follow the ROD. The MOX fuel Pu fraction would range, with reactor type, between 3 and 4.2 percent. MOX throughput depends on reactor type and ranges between 99 t/yr (109 tons/yr) and 118 t/yr (130 tons/yr) heavy metal (uranium and Pu). After discharge from the reactor, the spent MOX fuel assemblies would be stored at the reactor site for up to 10 years before further disposition. A typical LWR facility fuel cycle is depicted in Figure 2.4.5.2–2.

Construction. Major construction activities associated with the existing domestic LWRs that could be selected for this alternative have been completed. The use of MOX fuel in these reactors may require an internal modification to reactor site fuel receiving and storage buildings to properly secure the MOX fuel prior to its use. No significant additional land would be required for this construction.

Waste Management. During the fission process, radioactive products build up within the fuel. Virtually all of these products are contained within the fuel. However, a small fraction of the fission products can escape the fuel and contaminate the reactor coolant. The primary system coolant also contains radioactive contaminants as a result of neutron activation. The radioactivity found in the LWR coolant is the source of gaseous effluent, liquid effluent, and solid radioactive wastes. The following describes the basic design and operation of PWR and BWR radioactive waste treatment systems.

Gaseous Radioactive Effluents. For BWRs, an air ejector is the primary source of routine radioactive gaseous effluents released to the atmosphere. Air ejectors are used to remove noncondensable gases from the coolant to improve power conversion efficiency and reduce gaseous and vapor leakages to the atmosphere. After monitoring and filtering, the leakages are discharged to the atmosphere by the building ventilation system. The offgas treatment systems collect noncondensable gases and vapors exhausted from the condenser by the air ejectors. These offgases are then processed through a series of delay systems and filters to remove airborne radioactive particulates and halogens, thereby minimizing the quantities of radionuclides that might be released to the atmosphere. Building ventilation system exhausts are another source of gaseous radioactive emissions for BWRs.

The PWRs have three primary sources of gaseous radioactive effluents: discharges from the gaseous effluent management system, discharges associated with the exhaust of noncondensable gases from the main condenser (if a primary-to-secondary system leak exists), and radioactive gaseous discharges from the building ventilation exhaust. This includes discharges from the reactor building, the reactor auxiliary building, and the fuel-handling building.

The gaseous effluent management system collects fission products. These fission products consist mainly of inert gases that migrate to the primary coolant. A small portion of the primary coolant flow is continually diverted to the primary coolant purification, volume, and chemical control system to remove contaminants and adjust the coolant chemical makeup and volume. During this process, noncondensable gases are stripped and routed to the gaseous effluent management system, which consists of a series of gas storage tanks. The storage

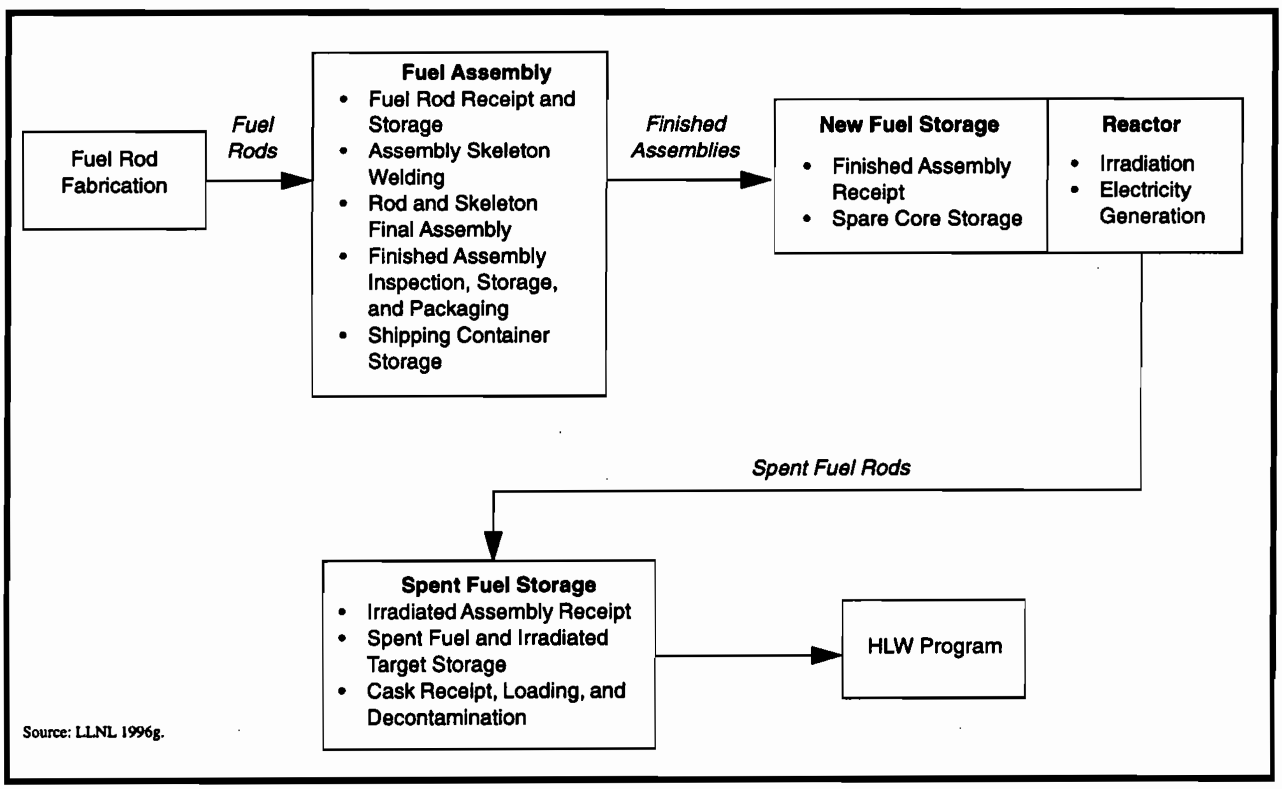


Figure 2.4.5.2–2. Representative Existing Light Water Reactor Fuel Cycle.

tanks allow the short half-life radioactive gases to decay, releasing only relatively small quantities of long half-life radionuclides to the atmosphere. In addition, some PWRs use charcoal delay systems rather than gas holdup tanks. Expected gaseous radioactive effluent is shown in Appendix F.

Liquid Radioactive Effluents. The source of liquid radioactive effluents in LWRs is radionuclide contaminants in the primary coolant. The specific sources, their mode of collection and treatment, and the types and quantities of liquid radioactive effluents released to the environment are similar in BWRs and PWRs. The following discussion applies to both BWRs and PWRs, with distinctions made only when important differences exist.

Liquid effluents from LWRs may be classified in the following categories: clean wastes, dirty wastes, detergent wastes, turbine building floor drain water (BWRs only), and steam generator blowdown (PWRs only). Clean wastes include all liquid effluents with normally low conductivity and variable radioactivity content. These wastes are collected from equipment leaks and drains, valve and pump seal leakoffs not collected in the reactor coolant drain tank, and other leakage sources.

Dirty wastes include all liquid effluents with moderate conductivity and variable radioactivity content that, after processing, may be used as reactor coolant makeup water. Dirty wastes consist of liquid effluents collected in the containment building sump, auxiliary building sumps and drains, laboratory drains, sample station drains, and other miscellaneous floor drains. Detergent wastes consist primarily of laundry wastes and personnel and equipment decontamination wastes. These wastes normally have a low radioactivity content. Water from the turbine building floor drain usually has high-conductivity and low-radionuclide content. In PWRs, steam generator blowdown can contain relatively high concentrations of radionuclides, depending on the amount of primary-to-secondary leakage present. Following treatment, the water may be reused or discharged.

Each of these liquid effluent sources receives varying degrees of and different types of treatment before storage for reuse. Some treated effluents can also be discharged by a site to the environment under the National Pollutant Discharge Elimination System (NPDES) permit. The extent and types of treatment depend on the chemical and radionuclide content of the effluent. To increase the efficiency of processing, effluents of similar characteristics are batched before treatment.

Operating plants have steadily increased the degree of treatment and storage of liquid radioactive effluents. In addition, extensive recycling of steam generator blowdown in PWRs is now common, and secondary side wastewater is routinely treated. Also, the systems used to treat effluents may be augmented with the use of commercial mobile treatment systems. As a result, radionuclide releases in liquid effluent from LWRs have generally declined. Expected liquid radioactive effluent is shown in Appendix E.

Solid Radioactive Waste. Nuclear power plants generate solid LLW through the removal of radionuclides from liquid waste streams, filtration of airborne gaseous emissions, and removal of contaminated material from various reactor areas. Concentrated liquids, filter sludges, waste oils, and other liquid sources are segregated by type and then flushed to storage tanks. They are stabilized for packaging in a solid form by dewatering, then slurried into 208-l (55-gal) steel drums and stored onsite in shielded buildings or other facilities until suitable for offsite disposal. These buildings usually contain volume reduction facilities to reduce LLW for offsite disposal.

High-efficiency particulate air (HEPA) filters are used to remove radioactive material from gaseous plant effluents. These filters are compacted in volume reduction facilities. The material is then disposed of as solid radioactive waste.

Solid LLW consists of contaminated protective clothing, paper, rags, glassware, compactible and noncompactible trash, and non-fuel-irradiated reactor components and equipment. Most of this waste comes from plant modifications and routine maintenance activities. Additional sources include tools and other materials contaminated from use in the reactor environment. Compacted dry radioactive waste is the largest single form of

LLW generated by nuclear plants, and it comprises one-half the total average annual volumes from PWRs and one-third of total average annual volumes from BWRs. Expected waste generated is shown in Appendix E.

Spent Nuclear Fuel. The formation of fission products and actinides when nuclear fuel is irradiated in reactors produces spent fuel. After it is removed from reactors, spent fuel is stored in racks in storage pools to isolate it and to allow the fuel to cool (that is, lose some radioactivity due to decay of the short-lived radioisotopes). Delays in siting a permanent repository, as well as the continual filling of spent fuel pools, have led utilities to seek other storage solutions. These solutions include high-density storage within the existing storage pools, aboveground dry storage, longer fuel burnup, and shipment of spent fuel to other plants.

Efforts are underway to develop dry storage technologies. These technologies include casks, silos, dry wells, and vaults. The NRC has already licensed a number of casks for utilization by public utilities. Dry storage is used by about 5 percent of the operating sites. These facilities are simpler and more readily maintained than fuel pools. They offer a more stable means of storage, occupy relatively little land area (less than 0.2 ha [0.5 acres] in most cases), and offer important economic advantages. Spent fuel is required to be maintained in the spent fuel storage pool for up to 10 years to allow for sufficient cooling. The increased number of MOX spent fuel assemblies shown in Table 2.4.5.2–1 would therefore need to be held in an existing pool for this same amount of time. All the plants studied have sufficient pool capacity to accommodate additional assemblies resulting from use of MOX fuel.

Table 2.4.5.2–1. Existing Light Water Reactor Facility Additional Spent Fuel Generation/Storage Requirements

	Spent Fuel Assemblies	
	PWR	**BWR**
Typical LEU-fueled plant	48	127
Additional for MOX-fueled plant (average)	32	15

Source: ORNL 1995b.

Transportation. There are five types of radioactive material shipments: LLW transported from plants to disposal facilities, LLW shipped to offsite facilities for volume reduction, nuclear fuel shipments from fuel fabrication facilities to plants for loading into reactors (which occurs on a 12- to 18-month cycle), spent fuel shipments from the storage pool at the reactor site to a repository (would only occur after a repository is recommended, approved, and licensed pursuant to the NWPA, and the particular fuel is accepted by the repository), and spent fuel shipments to other nuclear power plants with available storage space (an infrequent occurrence usually limited to plants owned by the same utility).

Waste packaging protects workers and the public from exposure during radioactive material transport. Operation restrictions on transport vehicles, ambient radiation monitoring, imposition of licensing standards (which ensure proper waste certification by testing and analysis of packages), waste solidification, and training of emergency personnel are also used.

A typical PWR creates approximately 44 shipments of LLW per year, while an average BWR makes 104 shipments per year. The majority of the LLW is shipped to disposal facilities by flatbed truck. These shipments are typically packaged in 208-l drums or other Type A containers. These containers must maintain sufficient shielding to limit radiation exposure to handling personnel and do not allow for release of radioactive material under normal transportation conditions.

Fresh MOX fuel is substantially more radioactive than fresh LEU fuel and would be shipped in Type B packages designed and certified for the shipment of unirradiated MOX fuel. One such package is Model No. MO-1 (Certificate No. 9069). Because the quantity of Pu in the fuel is greater than 6 kg (13.2 lbs), the unirradiated

MOX fuel package would be transported within an SST. A variant for this alternative is to use an existing European MOX fuel fabrication facility on a short-term basis. Pu feed material for the European facility would be transported across the global commons to the fabrication site. Similarly, the finished MOX fuel would be transported back to the United States across the global commons. An analysis of the transportation risks associated with this variant are presented in Appendix G.

After discharge from the reactor, spent fuel is placed in the spent fuel storage pool and allowed to cool until it can be sent to permanent disposal. Because of the limited size of spent fuel pools, some utilities have resorted to shipment of spent fuel between different reactors (usually within the same utility). For shipment, spent fuel is placed in Type B packages (called casks), and shipped by either truck or rail. Spent fuel shipping casks are very robust, and are designed to retain the highly radioactive contents under both normal and accident conditions.

A number of truck and rail casks are available for shipment of LEU spent fuel. Shipment of MOX spent fuel may require that each cask design be re-evaluated, and the NRC certificate may need to be amended to address the MOX spent fuel characteristics. Among the many casks designed for spent fuel, truck casks in the 23-t (25-tons) to 36-t (40-tons) range, such as (1) NAC-LWT (for one PWR or two BWR assemblies), (2) GA-4 (for four PWR assemblies), and (3) the GA-9 (for nine BWR assemblies), could be utilized.

2.4.5.3 Partially Completed Light Water Reactor Alternative

Under this alternative, commercial domestic LWRs on which construction has been halted would be completed and operated for disposition. The completed reactors would use MOX fuel in lieu of conventional LEU fuel. The characteristics of these units would essentially be the same as those of contemporary operating commercial LWRs discussed in Section 2.4.5.2. There are seven partially completed commercial LWRs located at four sites in the continental United States. The Bellefonte Nuclear Plant has been selected for study as a representative site for this alternative. As was stated for the Existing LWR Alternative, before the surplus Pu can be used as reactor fuel, a conversion process would be required to transform the Pu, in its various forms, into a usable form. Pit disassembly/conversion, Pu conversion, and MOX fuel fabrication facilities would be required to process the Pu into MOX fuel. All requirements shown in this section are in addition to those previously described for the pit disassembly/conversion, Pu conversion, and MOX fuel fabrication facilities. Since the reactors that would use the MOX fuel are in addition to existing commercial reactors, these partially completed reactors would create an additional amount of spent fuel to be added to the existing disposal requirements for uranium-based fuels.

In accordance with the Preferred Alternative for surplus Pu disposition, two partially completed LWRs could be selected. This would occur only after negotiations between DOE and interested parties, and through a competitive procurement process. Further tiered NEPA review will be conducted to examine locations should this option of the Preferred Alternative be selected at the ROD.

Facility Description. The partially completed LWRs contain the same four major components described in Section 2.4.5.2: the reactor building, the turbine building, auxiliary buildings, and cooling towers or ponds. A representative partially completed reactor site layout is depicted in Figure 2.4.5.3–1.

Facility Operations. Partially completed reactor facility operations would be generally the same as those described in Section 2.4.5.2. In this alternative, two partially completed reactors would be operated with an average MOX throughput of 68 t/yr (75 tons/yr) heavy metal.

Construction. Construction of two partially completed reactors would have to be completed to satisfy requirements under this alternative. Appendix C contains resources and personnel requirements necessary to complete construction of the typical pair of reactors. The construction of the partially completed LWR facility would require 7 years and have a peak annual employment of approximately 2,300 construction workers.

Waste Management. The solid and liquid nonhazardous wastes generated during construction would include concrete and steel construction waste materials and sanitary wastewater. The remaining nonhazardous wastes generated during construction would be disposed of as part of the construction project by the contractor. Uncontaminated wastewater could be used for soil compaction and dust control, and excavated soil would be used for grading and site preparation. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes generated during construction would consist of materials such as waste adhesives, oils, cleaning fluids, solvents, and coatings. Hazardous waste would be packaged in DOT-approved containers and shipped offsite to commercial RCRA-permitted treatment, storage, and disposal facilities. No radioactive waste would be generated during construction. Waste management requirements for operation are the same as those discussed in Section 2.4.5.2. Appendix F shows reactor average annual emissions during the peak construction year, respectively.

Transportation. Transportation requirements for the partially completed LWRs are the same as those discussed in Section 2.4.5.2.

2.4.5.4 Evolutionary Light Water Reactor Alternative

Evolutionary LWRs would be designed for the purposes of surplus Pu disposition and simultaneous production of electric power. As for the Existing LWR and Partially Completed LWR Alternatives, before the surplus Pu can be used as reactor fuel, a conversion process is required to transform the Pu, in its various forms, into a usable form. Pit disassembly/conversion, Pu conversion, and MOX fuel fabrication facilities would be required to convert the Pu into MOX fuel. Each fuel assembly loaded into a reactor would reside in the reactor between 4 and 5.4 years, during which time the reactor would be at power 75 percent of the time. After discharge from the reactor, the spent fuel assemblies would be stored at the reactor site for up to 10 years before further disposition. All requirements in this section are in addition to those previously described for the pit disassembly/conversion, Pu conversion, and MOX fuel fabrication facilities. Since the MOX-burning evolutionary reactors would be in addition to existing commercial reactors, these evolutionary reactors would create an additional amount of spent fuel to be added to the existing disposal requirement for uranium-based fuels.

Facility Description. Two evolutionary LWR design approaches, based on rated power (large and small reactor, designated large evolutionary LWR and small evolutionary LWR in the following discussion), are under consideration. There are three large evolutionary LWR designs: an approximately 1,400-MWe PWR, an approximately 1,250-MWe PWR, and an approximately 1,300-MWe BWR. A small, evolutionary LWR, approximately 600-MWe PWR, is also under consideration. For any design, an evolutionary LWR facility would consist of the following major components: the reactor, interim spent fuel storage, power conversion facility, and waste treatment facility. The planned Pu disposition campaign would require a minimum of two large evolutionary LWRs or four small evolutionary LWRs. The total disturbed land area for the evolutionary LWR operating facility would be approximately 138 ha (340 acres). In addition, a 1.6-km (1-mi) wide buffer zone around the facility may be required, depending on NRC licensing requirements. Figure 2.4.5.4–1 depicts a typical evolutionary LWR facility site plan. The major components of an evolutionary LWR facility are described below.

Reactor. The individual reactors would be an improved version of existing commercial electric power generating reactors using ordinary (light) water as both the moderator and coolant. The core, contained within a steel pressure vessel, would be composed of bundles of fuel rods. The fuel rods would consist of MOX fuel. The evolutionary LWR facility fuel cycle is depicted in Figure 2.4.5.4–2.

The cooling system selected, wet or dry, would depend on site characteristics. Both wet and dry cooling systems would use water as the heat exchange medium. Wet systems would use water towers and the evaporation process to carry off heat. Dry systems, designed for cold or high-humidity climates, would use water in closed nonevaporative cooling towers to remove heat by conduction to the atmosphere through heat exchangers. In moderate climates, fans would be added to the dry cooling towers to move air over the vanes of the heat exchangers. There would be some water loss through evaporation in a dry system, but significantly less than with a wet tower. Dry cooling towers would be used for the reactors at all dry sites. The use of wet cooling towers would be an option only for the power conversion facility and only when the facility would be located at a wet site.

Interim Spent Fuel Storage Facility. Spent fuel would be stored onsite in an underwater spent fuel storage pool.

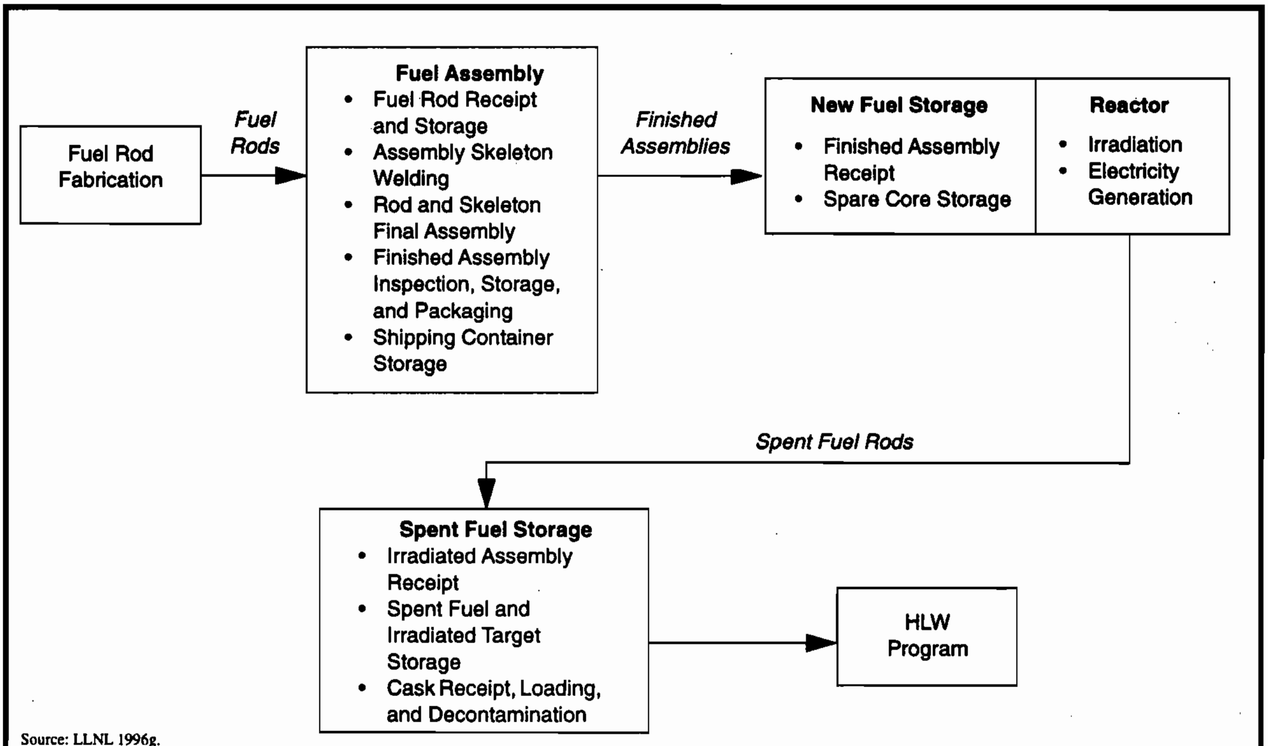
Power Conversion Facility. This facility would contain a turbine generator, electrical equipment, control equipment, auxiliary systems, plant support systems, and other equipment.

Waste Treatment Facility. This facility would receive all solid, liquid, and gaseous radioactive waste for storage, treatment, and packaging for either release or disposal at an appropriate permanent waste disposal facility.

Facility Operations. As a minimum, two large reactors or four small reactors would be operated to achieve 3.5 t to 4.1 t/yr (3.6 to 4.5 tons/yr) throughput for the disposition of surplus Pu and the simultaneous production of electric power.

Construction. The construction of the evolutionary LWR would require 6 years and have a peak annual employment of 3,500 construction workers. Additional land area required for construction is projected to be approximately 146 ha (360 acres). This provides for construction material laydown, warehousing, and temporary parking. Appendix C contains resources and personnel requirements required for the construction phase.

Waste Management. The solid and liquid nonhazardous wastes generated during construction would include concrete and steel construction waste materials and sanitary wastewater. The remaining nonhazardous wastes generated during construction could be disposed of as part of the construction project by the contractor.



Source: LLNL 1996g.

Figure 2.4.5.4–2. Representative Evolutionary Light Water Reactor Fuel Cycle.

Uncontaminated wastewater would be used for soil compaction and dust control, and excavated soil would be used for grading and site preparation. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes generated during construction would consist of materials such as waste adhesives, oils, cleaning fluids, solvents, and coatings. Hazardous waste would be packaged in DOT-approved containers and shipped offsite to commercial RCRA-permitted treatment, storage, and disposal facilities. No radioactive waste would be generated during construction.

The evolutionary reactor design considers and incorporates waste minimization and pollution prevention. Segregation of activities that generate radioactive and hazardous wastes would be employed, where possible, to avoid the generation of mixed wastes. Where applicable, treatment to separate radioactive and nonradioactive components would be performed to reduce the volume of mixed wastes and provide for cost-effective disposal or recycling. To facilitate waste minimization where possible, nonhazardous materials would be substituted for those materials that contribute to the generation of hazardous or mixed waste. Production processes would be configured with high priority given to minimization of waste production. Where possible, material from the waste streams would be treated to facilitate disposal as nonhazardous wastes. [Text deleted.]

Solid and liquid waste streams would be routed to the waste management system. Solid waste would be characterized and segregated into low-level, mixed, and hazardous wastes, then treated to forms suitable for disposal or storage within the facility. Liquid waste would be treated onsite to reduce hazardous/toxic and radioactive elements before discharge or transport. All fire sprinkler water discharged in process areas would be contained and treated as process wastewater.

Spent Nuclear Fuel. Fuel elements containing spent fuel would be stored for up to 3 years in water-cooled storage basins and up to 7 additional years in dry storage. The spent fuel pool would be equipped with an underwater canister loading system. Twelve spent fuel assemblies would be placed in fixed positions in a borated aluminum or stainless-steel basket for criticality safety. The basket would be contained in a canister whose lids are seal-welded in place. After the 3-year cooling period, the canisters would be drained, vacuum dried, and backfilled with helium through lid penetrations in preparation for dry storage. The canisters would be transferred in a cask to the interim spent fuel storage facility. At the storage facility, the canisters would be transferred into the final storage cask, which would be made of precast concrete and would hold one canister each. Casks would be placed on a concrete basemat. Periodic visual inspections of the canisters and the cask vents would be required. Periodic testing for helium leaks might also be required. Although the spent nuclear fuel is assumed to be stored at the reactor site for 3 to 10 years before further disposition, the facility design would have sufficient capacity to store the spent nuclear fuel for the life of the facility.

Transuranic Waste. The evolutionary LWRs would not generate any TRU waste.

Low-Level Waste. LLW would be generated by the operation of the reactor and support facilities. Process effluents would be temporarily stored in storage tanks before conversion into solid LLW that is suitable for disposal. The liquid effluent, after treatment, would be discharged through a permitted NPDES outfall. The bulk of the solid LLW would be generated in the reactor. Solid LLW would consist of contaminated equipment pieces, plastic sheeting, and protective clothing. This solid LLW would be compacted if appropriate and then disposed in a permitted onsite/offsite disposal facility.

Mixed Low-Level Waste. No liquid mixed LLW would be generated from operating the evolutionary LWR. Solid mixed LLW may originate from wipes laden with contaminated oils and hydraulic fluids. Mixed LLW would be stored in an onsite RCRA-permitted storage facility until treatment.

Hazardous Waste. Liquid hazardous waste would be generated from cleaning solvents, cutting oils, vacuum pump oils, film processing fluids, hydraulic fluids from mechanical equipment, antifreeze solutions, and paint. The cleaning solvent selected would be from a list of non-halogenated solvents. Liquid hazardous waste would be collected in DOT-approved containers and sent to an onsite hazardous waste accumulation area. The hazardous waste accumulation area would provide a 90-day staging capacity prior to shipment to an offsite commercial RCRA-permitted treatment, storage, and disposal facility. Solid hazardous waste would be generated from nonradioactive materials such as wipes contaminated with oils, lubricants, and cleaning solvents that are used for equipment outside the main processing units. After compaction, if appropriate, the solid hazardous waste would be packaged in DOT-approved containers and sent to a hazardous waste accumulation area for staging before shipment to an offsite commercial RCRA-permitted treatment, storage, and disposal facility.

Nonhazardous (Sanitary) Waste. Sewage wastewater would be treated in the sanitary wastewater treatment plant. Sewage wastewater would be kept separate from all industrial and process wastewaters and normally would contain no radioactive wastes from the reactor. The sewage wastewater would be routinely monitored for radioactive contaminants. The sludge would be disposed of in a permitted landfill. The treated effluent would be discharged through a permitted NPDES outfall (wet site) or recycled for cooling water makeup and other services (dry site). The treated effluent from the process wastewater treatment would be discharged to the river through an NPDES outfall. Other nonrecyclable, nonhazardous, solid sanitary, and industrial wastes would be compacted and disposed of in a permitted landfill.

Nonhazardous (Other) Waste. The evolutionary reactor design includes stormwater retention facilities with the necessary NPDES monitoring equipment. Rainfall within the LA and PA would be collected separately and routed to the stormwater collection ponds and then sampled and analyzed before discharge. If the runoff were contaminated, it would be treated in the radioactive waste treatment system. Runoff from the PPA may be discharged directly through an NPDES outfall into the natural drainage channels. Cooling tower blowdown would be treated and discharged to the outfall (wet site) or recycled for reuse (dry site). The treated effluent from the utility wastewater treatment would be discharged to the river through an NPDES outfall (wet site) or a natural drainage channel (dry site). All sludges would be disposed of in a permitted landfill.

Transportation. Transportation requirements for the evolutionary LWRs are the same as those discussed in Section 2.4.5.2.

2.4.5.5 Canadian Deuterium Uranium Reactor Alternative

Ontario Hydro operates 20 CANDU reactor units capable of using MOX fuel at five nuclear generating stations in the Province of Ontario. In addition, there is one CANDU reactor in the Province of Quebec and another CANDU reactor in New Brunswick. Under this alternative, surplus Pu would be removed from storage, processed through the pit disassembly/conversion or Pu conversion facility, packaged, transported to the MOX fuel fabrication facility, and converted into MOX fuel. The MOX fuel would be transported to and used in one or more CANDU reactors. The use of Canadian reactors would be subject to the approval, policies, and regulations of the Canadian Federal and Provincial governments.

Ontario Hydro Nuclear Bruce-A Generating Station has been identified as a reference facility by the Government of Canada and is used as a representative site for evaluation of the CANDU Reactor Alternative and the CANFLEX fuel bundle. The Ontario Hydro Nuclear Bruce-A Generating Station, containing four 769-MWe generating stations along with its four-unit sister station, Bruce-B, is located on Lake Huron about 300 km (186 mi) northeast of Detroit, Michigan.

Facility Description. The major components of a CANDU reactor are described below.

Reactor. An individual CANDU reactor has a horizontal, cylindrical, heavy-water filled, calandria tank containing 480 high-pressure fuel channel assemblies (also referred to as tubes) and reactivity control units. Heavy water, deuterium oxide (deuterium is a form of hydrogen with a neutron in its nucleus in addition to the proton of the hydrogen nucleus), is the neutron moderator and reflector. This entire assembly is contained in a light water-filled shield tank to form an integral structure that provides operational and shutdown shielding.

Power Conversion Facility. The turbine hall contains turbo-generators, electrical equipment, control equipment, auxiliary systems, plant support systems, and other equipment.

Vacuum Building. This facility is the focal point of the Negative Pressure Containment System.

Auxiliary Services Building. This facility houses supporting services for the Nuclear Generating Station.

Waste Treatment Facility. This facility would receive all spent fuel, solid, liquid, and gaseous radioactive waste for storage, treatment, and packaging for either release or disposal at an appropriate permanent waste disposal facility.

Facility Operations. The CANDU reactor MOX fuel cycle for CANDU fuel bundles in two CANDU reactors at the representative generating station would dispose of approximately 2.9 t/yr (3 tons/yr) of Pu based on a MOX throughput of 136 t/yr (150 tons/yr) heavy metal. Using the CANFLEX fuel design, four reactors would dispose of 5 t/yr Pu (5.5 tons/yr) based on a MOX throughput of 150 t/yr (165 tons/yr) heavy metal. The fuel cycle is depicted in Figure 2.4.5.5–1.

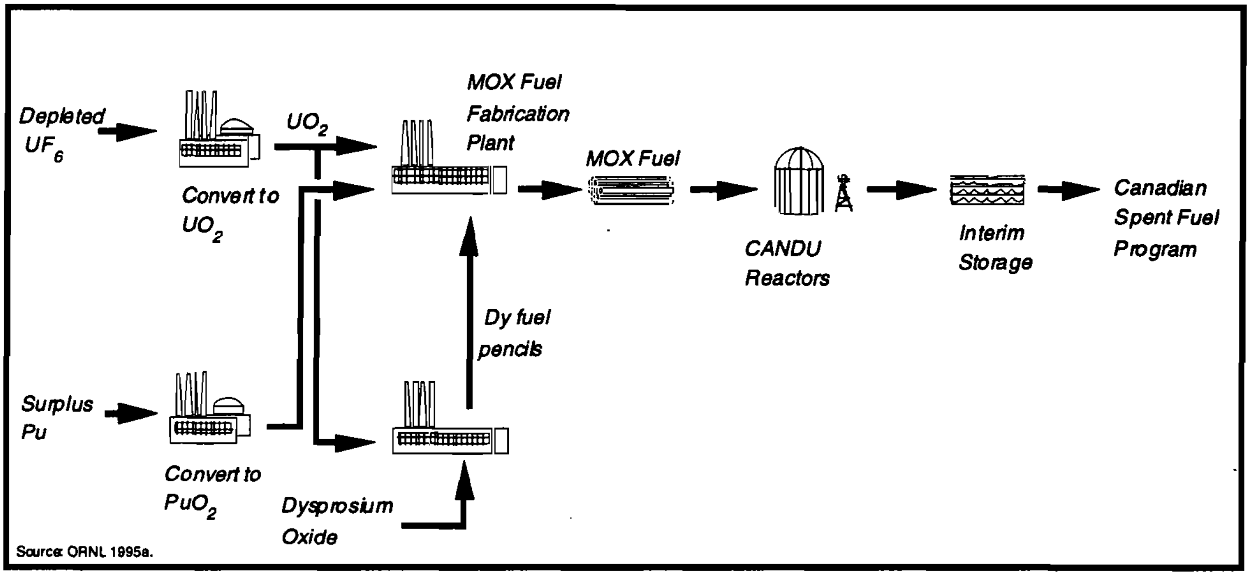


Figure 2.4.5.5–1. Canadian Deuterium Uranium Reactor Mixed Oxide Fuel Cycle.

Construction. The use of MOX fuel in the existing CANDU reactors may require a small addition to reactor site fuel receiving and storage buildings to properly secure the MOX fuel prior to its use. No significant additional land would be required for this construction.

Waste Management. Externally, MOX fuel and natural uranium fuel bundles are identical. The only difference, beside their fuel content, is the higher external radiation level of the MOX fuel bundle. The difference would not result in any increase in the quantity or hazard level of waste produced, processes employed, or facilities required for interim waste storage or disposal.

The Bruce Nuclear Generating Station has facilities for the storage of low-, medium-, and high-level radioactive MOX wastes. Spent MOX fuel bundles would be stored in CANDU wet storage spent fuel modules, equivalent to LWR spent fuel storage racks. Spent MOX fuel decay heat generation and fission product concentration would be similar to current CANDU fuel. The spent fuel resulting from using MOX fuel in the CANDU reactors would be the responsibility of Ontario Hydro and will be stored and disposed of in accordance with procedures established by the Canadian Atomic Energy Control Board.

Transportation. DOE would coordinate the transport of MOX fuel with the Canadian Federal and Provincial Governments. Transportation would be by commercial truck with appropriate security protection, or by SST, in accordance with applicable Federal regulation (49 CFR) and trucking industry practice to ensure safe, secure transport. Fresh MOX fuel bundles would be packaged in a standard stainless steel 208-l (55-gal) container. The packaging would be capable of holding seven CANDU MOX fuel bundles and would have to be certified as Type B packaging and approved for use within both Canada and the United States. The packaging would have to undergo certification by DOE, NRC, and DOT, as well as the Canadian Atomic Energy Control Board and Canadian Ministry of Transport. Although a packaging system has been approved in the United States for shipments of Category 1 materials, it has not yet been approved for the transport of CANDU MOX fuel bundles to Canada.

Based on the annual fuel requirement of 9,052 bundles (ORNL 1995a:26), approximately 54 truckloads per year would be required (slightly more than 1 per week). A brief technical description of MOX fuel use in a CANDU reactor is included in Appendix I.

2.5 COMPARISON OF ALTERNATIVES

The environmental impacts of the storage and disposition alternatives, including the Preferred Alternative, are compared in this section. The emphasis is on those environmental resources and issues that discriminate between the alternatives and are of interest to the public. At the end of this section, Table 2.5–1 provides a summary of environmental impacts for the Preferred Alternative for storage; Table 2.5–2 provides a comparison of environmental impacts for the No Action and long-term storage alternatives; and Table 2.5–3 provides a comparison of environmental impacts for disposition alternatives (including the Preferred Alternative).

2.5.1 LONG-TERM STORAGE ALTERNATIVES

Tables 2.5.1–1 through 2.5.1–6 present a comparison of the key environmental impacts for the long-term storage alternatives and the Preferred Alternative for storage. As discussed in Section 1.6, the Preferred Alternative for storage is a combination of No Action and Upgrade Alternatives for the various DOE sites, and phaseout of Pu storage at RFETS.

For all of the storage sites, the No Action Alternative is used as a baseline from which incremental impacts of the storage alternatives are compared. The phaseout associated with these storage alternatives could reduce human health and waste generation impacts and increase the number of lost jobs at some sites.

Site Infrastructure. For the Upgrade Alternative, all requirements would be within existing site capacities for all sites except for coal at ORR and SRS. Under the Preferred Alternative, coal consumption at ORR and SRS would exceed site storage capacities by less than 1 percent; all other requirements would be within existing site capacities. In those cases where site capacity for fuel storage does not adequately support increased requirements, more frequent deliveries would be scheduled. Increases in resource requirements would be within the following ranges over No Action: electrical energy, 0 to 104 percent (maximum for Pantex); peak electric load, 0 to 90 percent (maximum for Pantex); oil, 0 to 13 percent (maximum for INEL for the Upgrade Alternative); natural gas, 0 to 71 percent (maximum for Pantex); and coal, 0 to 1 percent (maximum for ORR).

For the Consolidation Alterative, all requirements would be within existing site capacities at all sites except for the following: electrical energy (12 percent over existing capacity), oil (1 percent over existing capacity), and natural gas (no existing capacity) at NTS; coal at INEL (97 percent over existing capacity); and oil (1 percent over existing capacity) and coal (2 percent over existing capacity) at SRS. In these cases where site capacity for fuel storage does not adequately support increased requirements, more frequent deliveries would be scheduled. Increases in resource requirements would be within the following ranges over No Action: electrical energy, 8 to 104 percent (maximum for Pantex); peak electric load, 9 to 90 percent (maximum for Pantex); oil, 1 to 5 percent (maximum for Pantex); natural gas, 0 percent (no existing capacity at NTS); and coal, 0 to 97 percent (maximum for INEL). All infrastructure requirements could be met by increasing procurement or, in the case of NTS, by using a different energy source.

For the Collocation Alternative, all requirements would be within existing site capacities at all sites except for the following: electrical energy (21 percent over existing capacity), oil (1 percent over existing capacity), and natural gas (no existing capacity) at NTS; coal at INEL (124 percent over existing capacity); oil (3 percent over existing capacity), and coal (35 percent over existing capacity) at ORR; and oil (1 percent over existing capacity) and coal (3 percent over existing capacity) at SRS. In these cases where site capacity for fuel storage does not adequately support increased requirements, more frequent deliveries would be scheduled. Increases in resource requirements would be within the following ranges over No Action: electrical energy, 8 to 126 percent (maximum for Pantex); peak electric load, 9 to 100 percent (maximum for Pantex); oil, 1 to 14 percent (maximum for ORR); natural gas, 0 percent (no existing capacity at NTS); and coal, 0 to 124 percent (maximum for INEL).

Soil, Cultural, and Paleontological. Ground disturbance during construction activities would potentially affect soil; cultural resources (including historic, prehistoric, and Native American); and paleontological resources. The Upgrade Alternatives and the Preferred Alternative would have fewer impacts because they use existing facilities or involve only small areas of ground disturbance. The Consolidation and Collocation Alternatives would have more impacts because they involve more ground disturbance due to the construction of new facilities.

Land Use and Visual Resources. For land use, the larger facilities associated with Consolidation and Collocation Alternatives would use more land (56 to 87 ha [138 to 215 acres]) than the facilities associated with Upgrade and Preferred Alternatives (0 to 0.1 ha [0 to 0.25 acres]). The Collocation Alternative at ORR would change the current Visual Resource Management (VRM) Class 4 designation of the Bear Creek Road/Route 95 intersection to Class 5. Visual resources at the other DOE sites would not be affected by the storage alternatives because the facilities would be located near other similar structures.

Air Quality and Noise. Since the Collocation and Consolidation Alternatives would result in more air emission sources (exhaust from delivery trucks, generators, and boilers), slightly greater air quality impacts would occur than with the Upgrade and Preferred Alternatives. The more extensive ground disturbance during construction associated with the Consolidation and Collocation Alternatives would also result in higher levels) of particulate matter less than or equal to 10 microns (PM_{10}) and Total Suspended Particulates (TSP) than for the Upgrade and Preferred Alternatives. Potential air emissions for all of the alternatives would be within applicable Federal, State, and local air quality standards and guidelines. Minimal noise impacts are expected from the storage alternatives because of the remote location of the facilities that would be modified or constructed.

Socioeconomics. Beneficial impacts to regional employment would be expected from all storage alternatives at all storage sites (Table 2.5.1–1) except for the site (or sites depending on the alternative) where storage would be phased out. Collocation would generate the largest employment, followed by the Consolidation, Upgrade, and Preferred Alternatives. However, the phaseout at RFETS associated with the Preferred Alternative would result in the loss of approximately 2,200 direct jobs. Due to the small number of the new jobs created by the alternatives relative to the size of the regional economies at all of the DOE sites, community services would not be affected by the long-term storage alternatives. Short-term local transportation impacts may result at all sites from the construction of the facilities associated with the storage alternatives. The larger construction projects (Collocation and Consolidation Alternatives) would have a greater potential to cause short-term congestion on local roads than the smaller construction projects (the Upgrade and Preferred Alternatives).

Water Resources. The water resource impacts for the Consolidation and Collocation Alternatives are greater than for the Upgrade and Preferred Alternatives, both in water requirements and wastewater discharges. Wastewater discharge is dependent on the number of employees, which is greatest for the Consolidation and Collocation Alternatives due to the larger facilities. As shown in Table 2.5.1–2, water resource requirements are the greatest for the Collocation Alternative at all DOE sites because collocation includes the maximum amount of Pu and HEU in the PEIS. Water resource requirements for all the alternatives would impact groundwater availability at Pantex because the additional groundwater withdrawal would contribute to the existing overall decline in water levels of the Ogallala Aquifer. However, there should be minimal impacts to regional groundwater levels from this additional withdrawal. At all other sites, water requirements would have minimal impact on water resources because of the abundance of surface water or groundwater.

Biological Resources. The Preferred Alternative would have no incremental biological resource impacts at INEL and Hanford, and minimal impacts at Pantex and potentially at SRS because of ground disturbance for upgrades. The Consolidation and Collocation Alternatives would have the potential to impact biological resources at all DOE sites because they would involve ground disturbance. At Pantex, previously disturbed land would be used for consolidation and collocation facilities. Threatened and endangered species at NTS and SRS may be affected by the storage alternatives at these sites.

Table 2.5.1–1. Maximum Incremental Direct Employment Over No Action Generated During Operation at Each Candidate Site

Site	Total Site Employment in 2005	Upgrade	Consolidation	Collocation	Preferred Alternative
Hanford	14,586	252[a]	443	572	0
NTS	3,800	NA	527[b]	641[b]	0
INEL	6,911	116[a]	432	561	0
Pantex	3,559	90[c]	509[d]	601	90[e]
ORR	18,010	111	[f]	566[g]	111
SRS	16,562	30[h]	485	614	30[h,i]

[a] Upgrade with RFETS and LANL materials.
[b] Modify P-Tunnel.
[c] Upgrade with RFETS and LANL materials. Actual number of employees during operation could be higher.
[d] Construct new and modify existing storage facilities.
[e] Upgrade with pits from RFETS.
[f] Since HEU is currently stored at ORR, the Consolidation and Collocation Alternatives would be the same.
[g] Construct new Pu and HEU facilities.
[h] Workers would be supplied from existing site workforce.
[i] Upgrade with non-pit materials from RFETS.
Note: NA=not applicable.

Table 2.5.1–2. Maximum Annual Net Incremental Water Usage Over No Action During Operation at Each Candidate Site

Site	No Action in 2005 (million l/yr)	Upgrade (million l/yr)	Consolidation (million l/yr)	Collocation (million l/yr)	Preferred Alternative (million l/yr)
Hanford	195	8.9[a]	110	150	0
NTS	2,400	NA	130[b]	190[b]	0
INEL	7,570	22[a]	66	87	0
Pantex	249	110[a]	110[c]	130	27.5[d]
ORR	14,760	0.24	[e]	360[f]	0.24
SRS	13,247	7.1[a]	360	460	5.7[g]

[a] Upgrade with RFETS and LANL materials.
[b] Modify P-Tunnel.
[c] Construct new and modify existing storage facility.
[d] Upgrade with pits from RFETS.
[e] Since HEU is currently stored at ORR, the Consolidation and Collocation Alternatives would be the same.
[f] Construct new Pu and HEU facilities.
[g] Upgrade with non-pit materials from RFETS.
Note: MLY=million liters per year; NA=not applicable.

Environmental Justice. All six DOE storage sites have, within an 80-km (50-mi) radius, census tracts with greater than 25 percent minority or low-income populations. However, the public health and safety analyses show that air emissions and hazardous chemical and radiological releases from normal operations for all storage alternatives would be within regulatory limits and that no latent cancer fatalities would result. The public health and safety analyses also indicate that radiological releases from accidents would not result in adverse human health or environmental impacts. Potential transportation accidents would be random events along transportation corridors. Therefore, none of the storage alternatives would have disproportionately high or adverse impacts on minority or low-income populations.

Waste Management. All of the storage alternatives would impact existing waste management practices at the DOE sites by increasing the amount of waste that must be treated, stored, and disposed. Depending on decisions in the waste-type-specific RODs for the Waste Management PEIS, wastes would be treated and disposed of onsite or at regionalized or centralized DOE sites. Generally, the Consolidation and Collocation Alternatives would generate more wastes than the Upgrade and Preferred Alternatives. Tables 2.5.1–3 through 2.5.1–5 show the maximum incremental waste generation rates for solid low-level, solid TRU, and solid hazardous wastes at the six candidate sites.

Table 2.5.1–3. Maximum Annual Net Incremental Volume of Solid Low-Level Waste Over No Action Generated During Operation at Each Candidate Site

Site	Waste Generated in 2005 (m^3)	Upgrade (m^3)	Consolidation (m^3)	Collocation (m^3)	Preferred Alternative (m^3)
Hanford	3,390	89[a]	1,260	1,300	0
NTS	15,000	NA	1,260	1,300	0
INEL	7,200	500[a]	1,260	1,300	0
Pantex	32	1,260[a]	1,260	1,300	138[b]
ORR	7,320	3	[c]	1,300[d]	3
SRS	16,400	0	1,220[e]	1,260[e]	0

[a] Upgrade with RFETS and LANL materials.
[b] Upgrade with pits from RFETS.
[c] Since HEU is currently stored at ORR, the Consolidation and Collocation Alternatives would be the same.
[d] Construct new Pu and HEU facilities.
[e] Net waste from new facility and from phaseout of existing facility.
Note: NA=not applicable.

Table 2.5.1–4. Maximum Annual Net Incremental Volume of Solid Transuranic Waste Over No Action Generated During Operation at Each Candidate Site

Site	Waste Generated in 2005 (m^3)	Upgrade (m^3)	Consolidation (m^3)	Collocation (m^3)	Preferred Alternative (m^3)
Hanford	271	21[a]	10	10	0
NTS	0	NA	10	10	0
INEL	3.5	2[a]	10	10	0
Pantex	0	10[a]	10	10	0.8[b]
ORR	119	0	[c]	10[d]	0
SRS	338	0	2[e]	2[e]	0

[a] Upgrade with RFETS and LANL materials.
[b] Upgrade with pits from RFETS.
[c] Since HEU is currently stored at ORR, the Consolidation and Collocation Alternatives would be the same.
[d] Construct new Pu and HEU facilities.
[e] Net waste from new facility and from phaseout of existing facility.
Note: NA=not applicable.

Table 2.5.1–5. Maximum Annual Net Incremental Volume of Solid Hazardous Waste Over No Action Generated During Operation at Each Candidate Site

Site	Waste Generated in 2005 (m^3)	Upgrade (m^3)	Consolidation (m^3)	Collocation (m^3)	Preferred Alternative (m^3)
Hanford	560	4	2	2	0
NTS	212	NA	2	2	0
INEL	1,200	1	2	2	0
Pantex	31	2[a]	2	2	1.5[b]
ORR	26	0.8[c]	[d]	2[e]	0.8
SRS	15,100	0.8[a]	2	2	0.6[f]

[a] Upgrade with RFETS and LANL materials.
[b] Upgrade with pits from RFETS.
[c] Total of mixed LLW and hazardous waste because hazardous waste is included in mixed LLW.
[d] Since HEU is currently stored at ORR, the Consolidation and Collocation Alternatives would be the same.
[e] Construct new Pu and HEU facilities.
[f] Upgrade with non-pit materials from RFETS.
Note: NA=not applicable.

Public and Occupational Health and Safety. Table 2.5.1–6 shows the differences between the long-term storage alternatives for radiological exposures to the public. The maximum potential latent cancer fatalities over No Action for the maximally exposed individual (MEI) over 50 years from normal operations ranges from 4.5×10^{-13} for the Upgrade and Preferred Alternatives at Pantex to 1.1×10^{-9} for the Collocation Upgrade Alternative at ORR. This means that the chance of a latent cancer fatality occurring ranges from about 1 in 1 billion to 5 in 10 trillion. The risk varies because of site parameters including the distance from the facility to the MEI (small sites vs. large sites); local meteorological conditions (windspeed, direction, and stability); and the type of material being stored (metals and oxides vs. residues).

Table 2.5.1–6. Maximum Latent Cancer Fatalities Over No Action for Maximally Exposed Individual for 50 Years From Normal Operation at Each Candidate Site

Site	No Action in 2005	Upgrade	Consolidation	Collocation	Preferred Alternative
Hanford	1.0×10^{-8}	4.5×10^{-11}	6.2×10^{-11}	6.2×10^{-11}	0
NTS	1.0×10^{-7}	NA	1.4×10^{-10}	1.4×10^{-10}	0
INEL	4.4×10^{-7}	1.3×10^{-11}	4.0×10^{-11}	4.0×10^{-11}	0
Pantex	1.5×10^{-9}	4.5×10^{-13}	2.4×10^{-10}	2.4×10^{-10}	4.5×10^{-13}
ORR	3.5×10^{-8}	5.5×10^{-13}	[a]	1.1×10^{-9}	5.5×10^{-13}
SRS	2.0×10^{-5}	2.1×10^{-10}	3.5×10^{-10}	3.5×10^{-10}	2.1×10^{-10}

[a] Since HEU is currently stored at ORR, the Consolidation and Collocation Alternatives would be the same.
Note: NA=not applicable.

Potential accidents were postulated for each of the long-term storage alternatives. The risk of cancer fatalities to the population located within 80 km (50 mi) of the accident release point for the accident scenario evaluated with the highest risk (PCV penetration by corrosion) for the Upgrade Alternative would be: 4.3×10^{-4} at Hanford; 1.6×10^{-3} at INEL; 8.8×10^{-4} at Pantex (Preferred Alternative); 3.0×10^{-5} at ORR (Preferred Alternative); and 4.6×10^{-4} at SRS. For both the Consolidation and Collocation Alternatives, the highest risk to the population located within 80 km (50 mi) of the accident release point associated with the accident scenarios evaluated (PCV penetration by corrosion) would be: 4.2×10^{-3} at Hanford; 5.1×10^{-5}/9.4×10^{-5} at NTS (P-Tunnel/New Pu and HEU Facility); 1.2×10^{-3} at INEL; 1.4×10^{-3} at Pantex; and 1.7×10^{-2} at ORR; and 4.6×10^{-3} at SRS. Since Pu accidents dominate the accident spectrum, the risks would be higher for the Consolidation and Collocation Alternatives then for the Upgrade Alternatives.

Intersite Transportation. For intersite transportation, the Upgrade and Preferred Alternatives would have lower potential for fatalities. For the Preferred Alternative, the number of potential fatalities ranges from 0 at Hanford and INEL (since there is no transport of material) to 0.06 at SRS. The Consolidation and Collocation Alternatives would have the higher potential for intersite transportation fatalities because they would move the greatest amount of material between sites. The number of potential fatalities ranges from 0.079 (Consolidated Storage Alternative at Pantex) to 1.07 (Collocated Storage Alternative at Hanford). Intersite transportation impacts would primarily result from nonradiological sources, such as fatalities from nonradiological traffic accidents.

2.5.2 DISPOSITION ALTERNATIVES

Table 2.5.2–1 depicts total campaign data for the disposition alternatives including the Preferred Alternative for disposition. A total of approximately 50 t (55.1 tons) of surplus Pu is assumed to be processed over the life of the campaign. In preparation for disposition under any alternative, surplus Pu must be processed through either the pit disassembly/conversion facility or the Pu conversion facility. Approximately 32.5 t (35.8 tons) are assumed to be processed at the pit disassembly/conversion facility, and approximately 17.5 t (19.3 tons) at the Pu conversion facility. Since these two facilities produce the input material for the other disposition facilities, actions at these two facilities would be the first to occur for the campaign. The operating period for these two facilities for each disposition alternative, including the Preferred Alternative, is 10 years.

Table 2.5.2–1. Total Campaign Data (Approximate) for Disposition Alternatives and the Preferred Alternative

	Disposition Alternatives			Preferred Alternative		
Action	Total Pu (t)	Throughput (t/yr)	Years In Operation	Total Pu (t)	Throughput (t/yr)	Years In Operation
Pit disassembly/ conversion	32.5	3.25	10	32.5	3.25	10
Pu conversion	17.5	1.75	10	17.5	1.75	10
Direct to borehole	50	5	10	NA	NA	NA
Immobilized to borehole	50	5	10	NA	NA	NA
Vitrification	50	5	10	17.5[a]	5[a]	3.5[a]
Ceramic immobilization	50	5	10	17.5[a]	5[a]	3.5[a]
Electrometallurgical treatment	50	5	10	NA	NA	NA
MOX fuel fabrication	50	3	17	32.5	3	11
5 existing LWRs[b]	50	3	17	32.5	3	11
2 partially completed LWRs[c]	50	3	17	NA	NA	NA
2 large or 4 small evolutionary LWRs	50	3	17	NA	NA	NA
CANDU reactors[d]	50	3.8	13	NA	NA	NA

[a] Either vitrification or ceramic immobilization would be implemented for immobilization of surplus Pu under the Preferred Alternative, but not both.

[b] Three to five existing LWRs would be used depending upon the amount of MOX fuel in the reactor core.

[c] If the partially completed LWRs were to be completed by other parties, they would be considered existing LWRs and could compete for the surplus Pu disposition mission under the Preferred Alternative.

[d] The CANDU reactor is retained in the event a multilateral agreement is made among Russia, Canada, and the United States to use CANDU reactors.

Note: NA=not applicable.

The operation of the disposition facilities for a single disposition alternative would require between 10 and 17 years to accomplish the disposition mission. However, the Preferred Alternative may result in fewer years of operation for the disposition facilities, since the 50 t (55.1 tons) of surplus Pu would be dispositioned under two different technologies. For purposes of analysis, it is assumed that approximately 17.5 t (19.3 tons) of surplus Pu would be immobilized through vitrification or ceramic immobilization, and approximately 32.5 t (35.8 tons) would be converted to MOX fuel for use in reactors,[21] under the Preferred Alternative. The number of years in operation for each disposition technology may be less than that required to process the full 50 t (55.1 tons) with any single disposition alternative.

Actual years of operation and Pu throughput rates for any of the reactor disposition alternatives would not exceed 17 years and 3.8 t/yr (4.2 tons/yr), respectively, but could be less depending upon the final reactor core design. Variables such as the amount of MOX fuel included in each core have not yet been determined and would affect the years required to complete the mission using the reactor alternatives. Conservative estimates for throughput and years in operation are presented for comparing the Reactor Alternatives with the Preferred Alternative.

Table 2.5.2–2 presents a comparison of the total campaign impacts from the disposition of 50 t (55.1 tons) of surplus Pu for key environmental resources for the individual disposition alternatives and the Preferred Alternative. Since the ceramic immobilization facility generally has greater impacts than the vitrification facility, it was used in the calculation of the total campaign impacts for the Preferred Alternative. A comparison of impacts is not included for community services, environmental justice, and noise since the impacts are highly site-specific.

Biological, Geology and Soil, Land Use, and Cultural and Paleontological Resources. Ground disturbance during construction activities would potentially impact soil; biological; cultural resources (including historic, prehistoric, and Native American); and paleontological resources for all of the disposition alternatives. The immobilization alternatives would disturb the least amount of land while the Evolutionary LWR Alternative would disturb the most land area because it would require the most new construction. However, when considering operational land area, the two Deep Borehole Alternatives would require the most land because of the 1.6-km (1-mi) radius buffer zone. Depending upon location, all of the alternatives could result in visual resource impacts by changing the visual resource management classification of an area. The Deep Borehole Alternatives would impact geologic resources because the borehole operations would render the site perpetually unusable.

Site Infrastructure and Water Resources. The evolutionary LWR would require the largest electrical load during operations. The Evolutionary LWR and the Partially Completed LWR Alternatives would require the most additional water for operations. The rest of the alternatives would require nearly the same amount of water, with the exception of the Electrometallurgical Treatment Alternative, which would require the least amount of water.

Air Quality and Socioeconomics. Potential construction-related impacts on air quality and local transportation would be minor for all of the disposition alternatives and the Preferred Alternative. The Evolutionary LWR and Partially Completed LWR Alternatives would generate the most employment and income among the alternatives. For local transportation, the Evolutionary LWR would have the greatest potential of reducing the level of service on local roads during construction and/or operations. Some reduction in level of service would also be expected for the Vitrification, Ceramic Immobilization, and the Preferred Alternatives.

Public and Occupational Health and Safety. There would be potential for impacts to public and occupational health and safety from the radiological and hazardous chemical doses during operations of all the disposition

[21] The actual amount dispositioned under each disposition technology would depend on subsequent NEPA analysis, costs, test and demonstration results, international agreements, and the procurement process, among other things.

Table 2.5.2–2. Comparison of Resource Use and Impacts From the Total Campaign for the Operation of Disposition Alternatives[a]

Alternatives	Total Number of Worker-Years	Water Usage (million l)	Latent Cancer Fatalities for MEI from Lifetime Accident-Free Operation	Solid TRU Waste Generated (m^3)	Solid Low-Level Waste Generated (m^3)	Solid Hazardous Waste Generated (m^3)
Direct to borehole	20,550	3,405	$1.2x10^{-9}$ to $1.2x10^{-7}$	3,452	18,500	287
Immobilized to borehole	29,550	6,605	$1.2x10^{-9}$ to $1.2x10^{-7}$	4,955	18,740	497
Vitrification	24,810	4,251	$1.2x10^{-9}$ to $1.2x10^{-7}$	4,440	18,590	307
Ceramic immobilization	25,730	4,251	$1.2x10^{-9}$ to $1.2x10^{-7}$	4,440	18,590	307
Electrometallurgical treatment	17,960	1,751	$1.2x10^{-9}$ to $1.3x10^{-7}$	3,510	19,000	125
5 existing LWRs[b]	29,030	2,717	$1.3x10^{-6}$ to $2.6x10^{-6}$	8,652	21,051	2,718
2 partially completed LWRs[c]	47,305	2,352,000	$9.8x10^{-6}$ to $9.9x10^{-6}$	8,652	22,955 to 42,709	3,636
2 evolutionary large LWRs[d]	53,850	2,062,000	$5.8x10^{-7}$ to $8.2x10^{-5}$	8,652	38,051	3,636
4 evolutionary small LWRs[e]	59,630	1,856,000	$8.4x10^{-7}$ to $9.6x10^{-5}$	8,652	39,411	4,554
CANDU reactors[f]	25,630	2,717	$1.8x10^{-9}$ to $1.2x10^{-7}$	8,652	21,051	2,718
Preferred Alternative[g]	16,140	3,253	$9.0x10^{-7}$ to $1.7x10^{-6}$	7,163	20,182	1,866

[a] Data includes all front-end processes (Pu conversion, pit disassembly/conversion, and MOX fuel fabrication) that would be needed for the individual alternatives. The total campaign impacts were calculated by multiplying the annual impacts times the number of years of operation, as identified in Table S.8–7.

[b] The table reflects the use of 5 existing LWRs. Three to five existing LWRs would be used depending upon the amount of MOX fuel in the reactor core.

[c] The table reflects the use of 2 partially completed LWRs.

[d] The table reflects the use of 2 evolutionary large LWRs.

[e] The table reflects the use of 4 evolutionary small LWRs.

[f] The table reflects impacts from pit disassembly/conversion and MOX fuel fabrication in the United States.

[g] Ceramic immobilization and five existing LWRs are the assumed technologies for the Preferred Alternative for comparative purposes only.

alternatives, including the Preferred Alternative; however, the annual radiological doses to onsite workers and the public would be within regulatory limits for all alternatives. For hazardous chemicals, potential impacts to the public and onsite workers would not be expected to cause adverse health affects.

A set of potential accidents was postulated for each of the disposition technology alternatives. The risk of cancer fatalities to the population located within 80 km (50 mi) of the accident release point for the front-end disposition process campaign would range from $4.5x10^{-16}$ to $1.7x10^{-4}$ for pit disassembly/conversion (for the highest accident risk scenario [fire on loading dock] at the potential disposition sites: $4.6x10^{-5}$ at Hanford;

$1.4x10^{-5}$ at INEL; $1.6x10^{-5}$ at Pantex; and $5.0x10^{-5}$ at SRS) and from $1.5x10^{-16}$ to $1.3x10^{-4}$ for Pu conversion (for the highest accident risk scenario [fire on loading dock] at the potential disposition sites: $3.5x10^{-5}$ at Hanford and $3.2x10^{-5}$ at SRS). Within the borehole category, the risk of cancer fatalities to the population located within 80 km (50 mi) of the accident release point for direct disposition campaign would range from $8.4x10^{-16}$ to $6.3x10^{-8}$. For both the ceramic immobilization front-end process prior to immobilized disposal, and ultimate disposition in the deep borehole complex, the risks would range from $9.3x10^{-18}$ to $6.3x10^{-8}$ and $9.3x10^{-19}$ to $6.3x10^{-9}$, respectively for the disposition campaign. The risk of cancer fatalities to the population located within 80 km (50 mi) of the accident release point for the immobilization category would range from $2.8x10^{-14}$ to $1.8x10^{-5}$ for the vitrification alternative and from $7.0x10^{-16}$ to $1.9x10^{-7}$ for the ceramic immobilization alternative over the disposition campaign (for the highest accident scenario [criticality] at the potential disposition sites and 30 percent immobilization campaign: $1.7x10^{-8}$ at Hanford and $2.1x10^{-8}$ at SRS). For the immobilization of Pu through electrometallurgical treatment of spent fuels, the projected campaign risk to the population would be $3.5x10^{-7}$ for the accident scenario evaluated with the highest risk (a breach in the argon cell initiated by a design basis earthquake).

For the reactor alternative, the risk of cancer fatalities to the population located within 80 km (50 mi) of the accident release point for the MOX fuel fabrication facility would range from $4.6x10^{-16}$ to $4.3x10^{-4}$ for the campaign (for the highest accident scenario [fire on loading dock] at the potential disposition sites using for analysis purposes, approximately 70 percent disposition campaign: $5.2x10^{-5}$ at Hanford; $1.6x10^{-5}$ at INEL; $1.8x10^{-5}$ at Pantex; and $5.2x10^{-5}$ at SRS). The risk of cancer fatalities to the population located within 80 km (50 mi) of the accident release point for the MOX-fueled evolutionary LWR would range from $9.6x10^{-11}$ to $6.9x10^{-6}$. Under the Preferred Alternative, DOE would pursue the use of MOX-fueled LWRs. The incremental effects of utilizing MOX fuel in a reactor in place of UO_2 were derived from a quantitative analysis of severe accident release scenarios for MOX and UO_2 using the MACCS computer code and generic population and meteorology data. The analysis only considers severe accidents where sufficient damage would occur to cause the release of Pu or uranium. The risks of severe accidents were found to be in the range of plus 8 to minus 7 percent, compared to UO_2 fuel, depending on the accident release scenario. The incremental risk of cancer fatalities to a generic population located within 80 km (50 mi) of the severe accident release point would range from $-2.0x10^{-4}$ to $3.0x10^{-5}$ per year.

Waste Management. The reactor alternatives and the Preferred Alternative would be the only alternatives that would generate spent nuclear fuel. The Partially Completed LWR Alternative would generate the largest incremental increase in spent nuclear fuel. The Preferred Alternative would generate the lowest incremental increase of spent nuclear fuel among the reactor alternatives because the combination of disposition technologies would require less Pu to go through reactors. The reactor alternatives and the Preferred Alternative would also generate the most solid TRU, solid low-level, and solid hazardous waste among the alternatives.

Intersite Transportation. The Evolutionary LWR and Partially Completed LWR Alternatives would have the highest potential fatalities over the total campaign because they would require the most material transport. The Preferred Alternative and Electrometallurgical Treatment Alternative would have the lowest potential fatalities from transportation. Intersite transportation impacts would primarily be the result of nonradiological impacts such as fatalities from nonradiological highway accidents.

Chapter 3
Affected Environment

3.1 DESCRIPTION OF ENVIRONMENTAL RESOURCES

The affected environment descriptions presented in this chapter provide the context for understanding the environmental consequences described in Chapter 4. As such, they serve as a baseline from which any environmental changes that may be brought about by implementation of the proposed action and alternatives can be identified and evaluated. The DOE sites evaluated include Hanford, NTS, INEL, Pantex, ORR, SRS, RFETS, and LANL. All eight DOE sites were evaluated under the No Action Alternative, and the first six were evaluated for long-term storage and disposition alternatives. Six of the DOE sites were evaluated for various disposition alternatives (for example, evolutionary LWR). The generic sites evaluated include a borehole site, a commercial MOX fuel fabrication facility, an existing LWR, and a partially completed LWR. The natural and human resources, as well as the facility-related resources that may be affected by the proposed action, are grouped into the following interest areas for analysis in this PEIS:

- Land resources
- Site infrastructure
- Air quality and noise
- Water resources
- Geology and soils
- Biological resources
- Cultural and paleontological resources
- Socioeconomics
- Public and occupational health and safety
- Waste management

In addition, the existing conditions and potential environmental impacts of intersite transportation of materials and environmental justice associated with the proposed action are described in Sections 4.4 and 4.5, respectively.

The alternatives defined in Chapter 2 are associated with the long-term storage of weapons-usable fissile materials and disposition of surplus Pu. In addition to these proposed actions, the No Action Alternative has also been assessed.

3.1.1 LAND RESOURCES

Definition of Resources

Land resources comprise all of the terrestrial areas available for economic production, residential or recreational use, governmental activities (for example, energy research facilities), or for natural resource protection. Primary concerns would be caused by changes in land use; conflicts with the objectives of applicable land-use plans, policies, and controls; and the degree of contrast between proposed development and the existing visual landscape. Potential effects to special status lands (for example, prime farmland, wilderness study area, or Wild and Scenic River), if any, are highlighted. The use or development of land resources is subject to regulation and must conform to governmental plans, policies, and controls at Federal, State, and local (regional, county, and municipal) levels.

Land Use. Land may be characterized by its potential for the location of human activities (land use). Natural resource attributes and other environmental characteristics could make a site more suitable for some land uses than for others. Changes in land use may have both beneficial and adverse effects on other resources (biological, geological, cultural, water, and air).

Visual Resources. Visual resources are natural and human-created features that give a particular landscape its character and aesthetic quality. Landscape character is determined by the visual elements of form, line, color, and texture. All four elements are present in every landscape; however, they exert varying degrees of influence. The stronger the influence exerted by these elements in a landscape, the more interesting the landscape. The more visual variety that exists with harmony, the more aesthetically pleasing the landscape.

Approach to Defining Environmental Setting

Land Use. The environmental setting for land resources was defined by first delineating the region of influence (ROI) and then gathering information on land-use patterns and densities pertaining to that area. The land-use ROI for alternatives to be constructed at current DOE installations includes lands within 3.22 km (2 mi) of the DOE sites. Land use associated with alternatives for which site-specific locations have not been identified are described generically, based on existing information about typical locations. Land-use data were obtained from data input reports; reviews of related environmental documents; information supplied by appropriate Federal, State, or local governmental agencies; maps; and photographs.

Visual Resources. Visual resource assessments were based on the Bureau of Land Management (BLM) VRM methodology. Management classes describe the different degrees of modification allowed to the basic elements of the landscape and are used to assess the visual effect of proposed development. Class designations are derived from an inventory of scenic quality, sensitivity levels, and distance zones of a particular area. The elements of scenic quality are landform, vegetation, water, color, adjacent scenery, scarcity, and cultural modification. Scenic value is determined by variety and harmonious composition of the elements of scenic quality. Sensitivity levels are determined by user volumes and user attention. Distance zones concern the relative visibility from travel routes or observation points. Distance zones include the following categories: foreground, 0.0 to 0.8 km (0 to 0.5 mi); middleground, 0.8 to 4.8 km (0.5 to 3 mi); background, 4.8 to 8 km (3 to 5 mi); and seldom seen, 8 km (5 mi) to infinity and areas blocked or screened from view. To determine how the visual resources of the site could be affected, the contrast of proposed development to the existing visual landscape (that is, visual resource inventory) and the sensitivity of viewpoints is analyzed.

The existing landscape at each analyzed site is assigned a VRM classification ranging from 1 to 5. Class 1 would apply to pristine areas, including designated wilderness areas and Wild and Scenic Rivers. Class 2 would apply to areas with very limited land development activity, resulting in contrasts that are seen but do not attract attention. Class 3 would apply to areas where contrasts caused by development activity are evident, but the natural landscape still dominates. Class 4 would apply to areas where contrasts caused by human activities attract attention and are dominant features of the landscape in terms of scale, but repeat the form, line, color, and texture of the characteristic landscape. Class 5 would apply to areas where contrasts caused by human activities are the dominant feature of the landscape to the point that the natural landscape character no longer exists. For alternatives involving new facilities at non-DOE sites, a generic environmental baseline was developed based on existing resource data from representative sites.

3.1.2 SITE INFRASTRUCTURE

Definition of Resources

Site infrastructure includes those utilities and other resources required to support construction and continued operation of mission-related facilities identified under the various alternative actions. The resources described and analyzed in this PEIS include electrical power and electrical load capacity requirements; natural gas, coal, and oil fuel requirements; and transportation networks, including roads and rail access.

Approach to Defining Environmental Setting

For existing DOE sites that may be selected or analyzed for actions under the proposed alternatives, projections of electricity availability, site development plans, and other DOE mid- and long-range planning documents were utilized to describe existing site infrastructure conditions. The ROI for existing DOE sites has been limited to the boundaries of those sites.

Under some of the PEIS alternatives, specific candidate sites are not identified. As a result, no planning documents are available to provide descriptions of the site infrastructure or to establish a detailed baseline from which environmental consequences can be estimated. For these cases, generic environmental baselines based on existing information about typical locations were developed in order to define conditions. For alternatives involving new facilities at non-DOE sites, the ROI is large enough to encompass the non-DOE site and the infrastructure construction to support the new facilities.

3.1.3 AIR QUALITY AND NOISE

Definition of Resources

Air Quality. Air pollution refers to any substance in the air that could harm human or animal populations, vegetation, or structures, or that unreasonably interferes with the comfortable enjoyment of life and property. For the purpose of this document, only outdoor air pollutants are addressed. Pollutants may include almost any natural or artificial compound capable of being airborne. They may be in the form of solid particles, liquid droplets, gases, or in combinations of these forms. Generally, they can be categorized as primary pollutants (those emitted directly from identifiable sources) and secondary pollutants (those produced in the air by interaction between two or more primary pollutants, or by reaction with normal atmospheric constituents, with or without photoactivation). Air pollutants are transported, dispersed, or concentrated by meteorological and topographical conditions. Air quality is affected by air pollutant emission characteristics, meteorology, and topography.

Ambient air quality in a given location has been described as the concentration of various pollutants in the atmosphere compared to the corresponding standards. Ambient air quality standards have been established by Federal and State agencies, allowing an adequate margin of safety for protection of public health and welfare from adverse effects associated with pollutants in the ambient air. Pollutant concentrations higher than the corresponding standards are considered unhealthy. Concentrations below the corresponding standards are considered acceptable.

The pollutants of concern are primarily those for which Federal and State ambient air quality standards have been established, including criteria pollutants, hazardous air pollutants, and other toxic air compounds. The criteria pollutants are those defined in 40 Code of Federal Regulations (CFR) 50, *National Primary and Secondary Ambient Air Quality Standards.* The hazardous air pollutants and other toxic compounds are listed in Title III of the 1990 *Clean Air Act* (CAA) as amended through May 1992, those regulated by the National Emissions Standards for Hazardous Air Pollutants (NESHAP), and those that have been proposed or adopted in regulations or are listed in guidelines by the respective States.

Noise. Sound results from the compression and expansion of air or some other medium when an impulse is transmitted through it. Sound requires a source of energy and a medium for transmitting the sound wave. The propagation of sound is affected by various factors, including meteorology, topography, and barriers. Noise is unwanted sound that interferes or interacts negatively with the human or natural environment. Noise may disrupt normal activities or diminish the quality of the environment.

Sound level measurements recorded to determine effects on humans are compensated by an A-weighted scale that accounts for the hearing response characteristics of the human ear. Sound levels are expressed in decibels (dB), or in the case of A-weighted measurement, decibels A-weighted (dBA). EPA has developed guidelines for noise levels for different land-use classifications. Some States and localities have established noise control regulations or zoning ordinances that specify acceptable noise levels by land-use category. These regulations are discussed in Appendix F for each site.

Approach to Defining Environmental Setting

Air Quality. The ROI for air quality would encompass the area surrounding the candidate site that is potentially affected by air emissions caused by the storage and disposition alternatives. Generally, the air quality impact area would cover a few kilometers downwind from the source. The area of the ROI depends on emission source characteristics, pollutant types, emission rates, and meteorological and topographical conditions. For the purpose of identifying the maximum air quality impacts from the proposed alternatives, an area within 10 km (6 mi) of the emission source has been selected as the impact area to be used in the air quality modeling analysis.

Meteorological and climatological data for each candidate site are obtained from the most recent site-specific environmental reports or *Local Climatological Data, Annual Summaries* produced by the National Oceanic and Atmospheric Administration (NOAA). One year of sequential hourly representative National Weather Service data from National Climatic Data Center or onsite meteorological data from the candidate site were obtained for air modeling analyses.

Areas with air quality better than the National Ambient Air Quality Standards (NAAQS) are designated as being in attainment; areas with air quality worse than the NAAQS are classified as nonattainment areas. Areas may be designated as unclassified when there is a lack of data to form a basis for an attainment status designation. The United States is divided into attainment, nonattainment, and unclassified areas by county, metropolitan statistical area, consolidated metropolitan statistical area, or portions thereof. Air Quality Control Regions (AQCR) designated by EPA are listed in 40 CFR 81, *Designation of Areas for Air Quality Planning Purposes.*

For locations that are in an attainment area, Prevention of Significant Deterioration (PSD) regulations limit pollutant emissions from new sources and establish allowable increments of pollutant levels. Three PSD classifications are designated based on criteria established in the CAA amendments. Class I areas include national wilderness areas, memorial parks larger than 20.2 square kilometers (km^2) (7.8 square miles [mi^2]), and national parks larger than 24.3 km^2 (9.4 mi^2). Class II areas include all areas not designated as Class I. Class III areas, which would allow greater deterioration than Class II areas, have not been designated.

Designation as a nonattainment area triggers control requirements designed to achieve attainment status by specified dates. In addition, facilities that constitute major new emission sources cannot be constructed in a nonattainment area without permits that impose stringent pollution control requirements to ensure progress toward compliance.

Baseline air quality of the affected environment is based on model predicted pollutant concentrations for existing sources at each site using concentrations presented in existing source documents or by modeling recent emissions data. Emissions data for existing sources are based on permit applications, the most recent site-specific environmental reports, or emission inventories.

For the generic environments used to establish a context for comparison of relative impacts from Pu disposition technologies, the assessment of potential air impacts resulting from the implementation of these technology options is not directed to specific locations, but instead to a generic site in the continental United States. For a generic site, no site-specific air pollutant emissions data can be determined. Generic site information pertaining to air quality is described with respect to air quality within the continental United States. Site-specific air quality analyses of applicable disposition alternatives would be addressed in tiered NEPA documentation, as appropriate.

Toxic air pollutants are addressed in both the air quality and noise section and the public and occupational health section for each of the candidate sites. In the air quality section, the maximum concentration of toxic air pollutants at or beyond the site boundary is compared with a Federal, State, or local standard to determine compliance. In the Public and Occupational Health section, a health risk is calculated based upon chemical concentration and toxicity compared to the Reference Concentration (RfC) for the public and the Permissible Exposure Level (PEL) for workers for noncancer causing chemicals and slope factors for the public and workers for cancer causing chemicals. The cancer effects are a risk that is based on the slope factor (cancer potency) for chemicals that are regulated as carcinogens.

These differences in analytical methods result in the different pollutants analyzed between the air quality analysis and the public and occupational health analysis. In the air quality analysis, toxic pollutants with low emission rates in most cases will result in extremely low concentrations at the site boundary and therefore are not presented in the air quality analysis. In the public and occupational health analysis, many of the same chemical pollutants may expose an onsite worker located 100 m (328 ft) from the emission source to a health risk, and therefore are presented in this analysis. The hazardous chemical pollutants used by these two disciplines to evaluate impacts will be different. Compliance to standards does not consider what health effects are expected nor the interaction between several chemicals that may together cause adverse health responses even if they separately are at below standard concentrations.

Noise. Noise from facility operations and traffic has the potential to affect local human and animal populations. Because most nontraffic noise associated with construction and operation of the proposed facilities is located at sufficient distance from offsite noise-sensitive receptors, the contribution to offsite noise levels is expected to be small. Impacts associated with access routes, including noise from increased traffic, are not analyzed in this document because information that would be needed for such an assessment has not been developed at this programmatic level of analysis. No acoustics-related impacts are anticipated to affect DOE's decision on the proposed facilities. The level of detail describing both the onsite and offsite acoustical environment is presented accordingly.

To provide a context for comparison of these potential acoustical impacts, the existing acoustical environment has been briefly described in terms of existing noise sources, sound level measurements that are available for the ROI, and the range of sound levels that is typical of the land uses in the ROI. The ROI for each of the alternatives includes its site and surrounding areas where related activities might increase noise levels, including transportation corridors in which noise levels could be affected by proposed activities.

In recent years, several DOE sites have compiled sound-level data representative of adjacent areas and transportation routes that serve the site. Where these data are available, they are presented. The *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety* (EPA-550/9-74-004, March 1974) has identified ranges of sound levels that are typical of various land uses. These ranges of sound levels have been presented for each DOE site. For generic sites, a broad range of sound levels has been identified based on typical land uses adjacent to these types of sites.

3.1.4 WATER RESOURCES

Definition of Resources

Surface Water. Surface water includes marine or freshwater bodies that occur above the ground surface, including rivers, streams, lakes, ponds, rainwater catchments, embayments, and oceans. Surface water quality is characterized by the concentration of inorganic, organic, and biological constituents in surface waters. Surface water bodies are classified based on designated uses that are to be protected (for example, drinking water supply, contact recreation, or cold water fish habitat). Federal, State, and local regulations set standards and criteria that apply to the different classifications. Potable water sources (both surface and groundwater) are regulated by the *Safe Drinking Water Act* (SDWA), while the *Clean Water Act* (CWA) protects the overall quality of the Nation's surface waters. These regulations are summarized in Appendix J.

Groundwater. Groundwater resources are defined as the aquifers underlying the site and their extensions down the hydraulic gradients to, and including, discharge points and the first major users. Groundwater quality, like that of surface water, is characterized by the concentration of its inorganic, organic, and biological constituents. Geology, soils, and the quality of surface water and other sources of aquifer recharge are the main factors affecting groundwater quality.

The quantity of groundwater an aquifer yields is directly related to its geologic properties. In general, the higher the porosity (a measure of void space) and permeability (the interconnectedness of the void space), the greater the aquifer yield. The recharge rate is the rate at which groundwater accumulates in the aquifer and represents the rate at which groundwater can be withdrawn from the aquifer without a net reduction in the quantity of groundwater in storage. Groundwater resources are specifically protected by Federal law under SDWA by the Sole Source Aquifer and Wellhead Protection programs. State and local regulations may provide additional protections, classifications, standards, or criteria.

Approach to Defining Environmental Setting

Surface Water. Surface and groundwater affected by or used in conjunction with site activities define the affected environment in terms of water resources. Surface water resource elements include surface water bodies, flow characteristics, stream classifications, and floodplains.

In support of surface water impact assessment, data obtained from documents (U.S. Geological Survey [USGS] and other Federal Government technical reports and State and local reports and databases) are used to describe major surface water features and to establish current or baseline surface water conditions at the sites. Current surface water usage includes use of surface water or offsite sources (municipal water). The existing water supply was evaluated to determine quantities of available water, capacity of the supplier, and existing water rights, agreements, or allocations. Major stream flows and stream classifications are identified when they are used as a water source or receive effluent discharge from the site. In cases where low flow data are unavailable, average flow data are used.

The water quality of potentially affected receiving waters are determined by reviewing current monitoring data primarily for radiological and nonradiological parameters. Significant known surface water contamination at the site is described. Where applicable, the site NPDES permits are briefly described and the status of compliance with permit limits and requirements is summarized.

One hundred-year floodplains and flooding history of the site, when applicable, are identified at the sites to determine whether areas of the site might be affected by high waters. When possible, the 500-year floodplain is also identified. Specific facility locations will be addressed in tiered environmental analyses, as required.

To define a reasonable generic surface water quality affected environment for alternatives that are not site-specific, a range of existing surface water quality conditions has been presented using water resources data from USGS.

Although baseline surface water quality may be defined by a multitude of parameters, for the purposes of this PEIS the baseline will be defined by those constituents expected to be released or affected by the disposition alternatives. Baseline conditions for parameters such as those regulated under SDWA will provide a basis for evaluating impacts of these alternatives.

Water usage and availability at a generic site are characterized by precipitation. In areas where rainfall is abundant and population is dense, water supply is commonly obtained from local surface water reservoirs and shallow wells. In arid climates, water supply is commonly obtained from deep wells and manmade lakes created by damming major rivers. In humid climates, water supply is generally derived from surface water taken from major waterways. Local constraints include seasonal fluctuations in precipitation, consumption by other facilities using the same water supply, and State regulations, such as the water appropriation permit requirements.

Groundwater. For site-specific analyses, the affected environment discussion includes a description of the potentially affected groundwater basins. The aquifers underlying the site, their extension down the hydraulic gradient to, and including, discharge points, and the first major users are described. The local aquifers are described in terms of the extent, thickness, character of rock formations, recharge and discharge areas, and quality of the groundwater. Aquifers are classified by Federal and State authorities according to use and quality. The Federal classifications include Class I, II, and III groundwater. Class I groundwater is either the sole source of drinking water or is ecologically vital. Class IIA and IIB are current or potential sources of drinking water (or other beneficial use), respectively. Class III is not considered a potential source of drinking water and is of limited beneficial use. Sole source aquifers are identified when located near a DOE site. When applicable, current groundwater usage at the site is identified. Any allocations, existing water rights, or agreements are briefly described.

Available data on existing groundwater quality conditions are compared to Federal and State groundwater quality standards, effluent limitations, and safe drinking water standards. When applicable, known contaminated groundwater areas at the site are described.

Generic descriptions of groundwater availability are developed based on general water supply characteristics. Overdraft of groundwater occurs when water is withdrawn from sources that cannot be renewed or is withdrawn more quickly than it can be recharged. Several areas of the country are experiencing critical groundwater overdraft more than 1,900 million l/day (500 million gal/day) of overdraft, and have low surface water availability relative to demand (VDL 1990a:725).

Many other areas of the country are experiencing moderate overdrafts of 80 to 1,900 million l/day (21.2 to 500 million gal/day) with moderate-to-low levels of surface water availability relative to demand. Other areas experience no overdraft of groundwater supplies or have an adequate supply of surface water relative to demand. The settlement of inter- and intrastate water rights issues that are ongoing or may occur could cause the potential water availability for an area to change and are discussed as applicable.

3.1.5 GEOLOGY AND SOILS

Definition of Resources

Geology resources are consolidated or unconsolidated earth materials, including mineral assets, such as ore and aggregate materials, fossil fuels, and significant landforms. Soil resources are the loose surface materials of the earth in which plants grow, usually consisting of disintegrated rock, organic matter, and soluble salts.

Approach to Defining Environmental Setting

The ROI for geology and soil resources comprises all areas subject to physical disturbance by construction and operational activities associated with an alternative. The exact location of each alternative is not known at this time. Therefore, the ROI may vary from either the area disturbed, for those sites already identified, to the entire site, for those alternatives whose location is unspecified. For alternatives not linked to specific candidate sites, a generic description encompassing a range of likely geologic and soil settings was developed.

The occurrence of geology and soil resources, as well as their status and viability at the various sites proposed, can vary greatly. The geology and soil resources were considered both with respect to the identification of those portions of the resource that could be affected by the alternative and the presence of natural conditions that may affect the alternative. Geology and soil conditions that may affect the integrity and safety of the proposed alternatives are a primary consideration. Specific geologic considerations include seismic activity (vibratory ground motion), volcanism, unique geologic resources, and karst terrain. Specific soil considerations include suitability of soil for construction, soil quality, and erosion.

The physiographic province and geologic setting have been provided for specific sites. For those alternatives that are not site-specific, a range of conditions has been provided. Earthquake potential was evaluated based on the frequency, magnitude, and intensity of past events; the location and distribution of epicenters; and the location of capable faults as defined in 10 CFR 100, Appendix A. The potential for volcanic activities was similarly evaluated. Areas of past mass movements (landslides and other forms of material transport) and conditions favorable for future mass movement were identified, including karst terrains, landslide-susceptible rock and soil materials, and excessive slopes.

Information on the geology and soil resources was derived from the most recent and applicable reports, aerial photographs, and other literature (for example, environmental assessments [EAs], EISs, and facility plans). For those alternatives where the site location has not been identified, information may have been obtained through the following additional sources: DOE; BLM; Bureau of Reclamation, Mineral Management Service; EPA; USGS; and the Soil Conservation Service.

3.1.6 BIOLOGICAL RESOURCES

Definition of Resources

Biological resources are defined as terrestrial and aquatic ecosystems characterized by the presence of native and naturalized flora and fauna. For the purposes of this PEIS, biological resources include terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. Although wetlands and threatened and endangered species could be considered as either terrestrial or aquatic resources, they have been identified for separate analysis in this PEIS because of their special regulatory status.

Terrestrial Resources. Terrestrial resources are defined as those plant and animal species and communities that are most closely associated with the land. For the purposes of this PEIS, terrestrial resources include the major plant communities present in a site or region and the vegetation, amphibians, reptiles, birds, and mammals found within them. Scientific names of non-special status species (both terrestrial and aquatic) listed in the text are provided in Appendix K.

Wetlands. Wetlands are defined by the U.S. Army Corps of Engineers (COE) and EPA as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (33 CFR 328.3). Thus, wetlands are delineated based upon the occurrence of characteristic vegetation, soils, and hydrology (USCOE 1987a:13-14).

Aquatic Resources. Aquatic resources are defined as those plant and animal species and communities that are most closely associated with a water environment. For the purposes of this PEIS, aquatic resources include the major habitats present in a site or region and the fish species found within them.

Threatened and Endangered Species. Endangered species are defined under the *Endangered Species Act* (ESA) of 1973 (see Appendix J) as those in danger of extinction throughout all or a large portion of their range. Threatened species are defined as those species likely to become endangered within the foreseeable future. The U.S. Fish and Wildlife Service (USFWS) may designate areas of critical habitat for threatened and endangered species. Critical habitat is defined as specific areas that contain physical and biological features essential to the conservation of species and that may require special management considerations or protection. Species that are Federal proposed or candidates for listing as threatened or endangered species do not receive legal protection under ESA. However, the USFWS recommends that impacts to these species be considered in project planning since their status can be changed to threatened or endangered in the foreseeable future. The USFWS has recently changed the classification of species under review for listing as threatened or endangered (61 FR 7596). Proposed species include those plants and animals for which a proposed rule to list as threatened or endangered has been published. Candidate species include those plants and animals for which the USFWS has on file sufficient information on biological vulnerability and threat to support issuance of a proposed rule for listing as endangered or threatened. Candidate species previously included Category 1 (species appropriate for listing as protected) and Category 2 (species possibly appropriate for listing as protected). Due to the recent rule change, candidate species include only those which are appropriate for listing as protected species (i.e., species formerly listed as Category 1). The Category 2 designation has been omitted. Some of the species previously identified as Federal candidate Category 2 in the Storage and Disposition Draft PEIS also have a State status and continue to be evaluated for potential impacts. However, due to the change in candidate classification described above, many species have been eliminated from proposed site threatened and endangered species lists. At the State level, protected species are classified into a variety of categories, including endangered, threatened, sensitive, protected, in need of management, of concern, monitored, or species of special concern.

Approach to Defining Environmental Setting

Since some alternatives presented in this PEIS are site-specific and others are not, the existing environment is discussed at two levels. Where alternatives are associated with specific sites, such as for the storage alternatives, or an assumed location on a DOE site for a number of disposition facilities, the existing environment of those actual sites is addressed. However, these sites are only described when previously undisturbed areas would be affected. Biological resources addressed include terrestrial resources, wetlands, aquatic resources, and threatened and endangered species. Where site locations have not been selected, a more generic discussion is presented. This discussion addresses selected biological resources, including natural habitats (both terrestrial and aquatic), wetlands, threatened and endangered species, and migratory birds. The ROI for site-specific alternatives includes the entire DOE site under consideration, while for non-site-specific alternatives it includes conditions representing various regions of the United States within which the alternative could be located. Data sources used include site-specific studies, as well as regional summaries, as appropriate. Specific data sources include DOE site studies, National Wetland Inventory (NWI) Maps, and USFWS and Natural Heritage Program records on threatened and endangered species.

3.1.7 CULTURAL AND PALEONTOLOGICAL RESOURCES

Definition of Resources

Cultural resources are human imprints on the landscape and are defined and protected by a series of Federal laws, regulations, and guidelines. For this PEIS, cultural resources are separated into prehistoric, historic, and Native American resources. Paleontological resources, although not governed by the same laws on historic preservation, represent a similar type of surface or buried resource that may be affected in the same way as cultural resources. Paleontological resources also will be considered in this section.

Prehistoric Resources. Prehistoric resources are physical properties that remain from human activities that predate written records. These resources generally are identified as either isolated artifacts, sites, or districts. Isolated artifacts may include stone or bone tools, or remains of ceramic pottery. Sites may contain concentrations of artifacts (for example, stone tools and ceramic sherds), features (for example, remains of campfires, residences, or food storage pits), and plant and animal remains. All of these resources can be used to reconstruct life in a region or at a limited location. Depending on their age, complexity, integrity, and relationship to one another, sites may be important for, and capable of, yielding otherwise inaccessible information about past populations.

Historic Resources. Historic resources consist of physical properties that postdate the existence of written records. In the United States, historic resources are generally considered to be those that date no earlier than 1492. Historic resources include architectural structures or districts (for example, religious, commercial, or residential structures, dams, and bridges), archaeological objects, and archaeological features (for example, foundations of mills or residences, trails, and trash dumps). Ordinarily, sites less than 50 years old are not considered historic for analytical purposes, but exceptions can be made for younger properties if they are of exceptional importance, such as structures associated with Cold War themes (36 CFR 60.4).

Native American Resources. Native American resources are sites, areas, and materials important to Native Americans for religious or heritage reasons. In addition, cultural values are placed on natural resources such as plants, which have multiple purposes within various Native American groups. Of primary concern are concepts of sacred space that create the potential for land-use conflicts. Native American resources can include geological or geographic elements such as mountains or creeks; certain species of plants and animals; cemeteries, battlefields, trails, and pueblos; and archaeological sites.

Paleontological Resources. Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geological age. They include casts, molds, and trace fossils such as burrows or tracks. Fossil localities typically include surface outcrops, areas where subsurface deposits are exposed by ground disturbance, and environments that favor preservation, such as caves, peat bogs, and tar pits. These resources are important because they provide scientific information on paleoenvironments and the evolutionary history of plants and animals.

Approach to Defining Environmental Setting

The ROI for cultural and paleontological resources is bounded in three ways. First, there is the general natural setting. This is the location of the resource within a specific geological and geographical region, which can include significant bodies of water such as rivers or lakes; topography, such as slopes, plains, or mountains; and plants and animals that once inhabited or still inhabit the region. Because this natural region affects the location of a given prehistoric or historic resource and the life of its inhabitants, information regarding it is important for describing cultural or paleontological resources. Second, there are the modern political boundaries of the site. This PEIS includes data based on surveys of cultural and paleontological resources that may include an entire site or may include a portion of a specific site. Finally, and most specifically, there is the area directly affected or disturbed by a proposed alternative during construction or operation, including visual intrusions to the settings or environmental context, unauthorized artifact collecting, and vandalism. In the cases of prehistoric, historic, and paleontological resources, Federal and State regulations regarding impacts are usually expressed in terms of the last ROI definition. Native American resources affected may also include viewsheds, plant communities, or resources such as mountains that are outside the potentially disturbed acreage, but may still be affected by a proposed alternative. Effects to Native American resources also include visual and audio intrusions to sacred sites and reduced access to traditional use areas. In this PEIS, each of these increasingly focused ROIs is addressed. For generic alternatives where a site is not specified, the ROI is described as a range of potentially affected resources.

Data used to assess the potentially affected cultural or paleontological resources at specific sites include information regarding the historic and prehistoric context of the proposed project area, its geology and paleontological potential, and the possible presence of sites, districts, or objects that may be eligible for listing on the National Register of Historic Places (NRHP) or may be significant to Native American groups. For non-site-specific alternatives, a general description of possible cultural or paleontological resources is presented.

Prehistoric Resources. The affected environment section for prehistoric resources includes a brief overview of the number and types of prehistoric sites in the ROI, if known, and their status on the NRHP. A summary of existing information about prehistoric resources in the ROI is provided, and the types of sites that are likely to occur are discussed.

Historic Resources. The affected environment section for historic resources includes a brief overview of the number and types of historic sites in the ROI, if known, and their status on the NRHP. The overview consists of a summary of existing information about historic resources in the ROI and a discussion of the types of sites that are likely to exist.

Native American Resources. The affected environment section for Native American resources includes a brief overview of the regional Native American groups whose resources may be affected, along with the number and types of sites, use areas, and other resources in the ROI, if known, and their status or significance. A summary of existing information about Native American resources in the ROI is provided, and the type of resources that are likely to exist is discussed.

Paleontological Resources. The affected environment section for paleontological resources includes a description of known paleontological localities and geological formations in the project areas that may be fossil-bearing.

3.1.8 SOCIOECONOMICS

Definition of Resources

Socioeconomics comprises the social, economic, and demographic characteristics of an area. The socioeconomic environment can be affected by changes in employment, income, and population, which, in turn, can affect area resources such as housing, community services, and infrastructure.

The socioeconomic analysis assesses the environmental consequences of demographic and economic changes resulting from proposed alternatives. The study focuses on the potential impacts of a change in the number of workers and their families on the economy, housing availability, community services, and infrastructure. This PEIS assesses health care, education, and public safety as representative indicators of community services. Local transportation is assessed as a representative indicator of community infrastructure. [Text deleted.]

Approach to Defining Environmental Setting

The socioeconomic environment is defined for two geographic regions: the regional economic area (REA) and the ROI. REAs are used to assess potential effects on the regional economy, and ROIs are used to assess effects that are more localized in political jurisdictions surrounding the sites.

The REA for each site encompasses a broad market that involves trade among and between regional industrial and service sectors and is characterized by strong economic linkages between the communities in the region. These linkages determine the nature and magnitude of multiplier effects of economic activity (purchases, earnings, and employment) at each site. REAs are defined by the U.S. Bureau of Economic Analysis (BEA) and consist of an economic node that serves as the center of economic activity and the surrounding counties that are economically related and include the places of work and residences of the labor force.

Potential demographic impacts were assessed for the ROI, a smaller geographic area where the housing market and local community services would be the most affected. Site-specific ROIs were identified as those counties where approximately 90 percent of the current DOE and contractor employees reside. This residential distribution reflects existing commuting patterns and attractiveness of area communities for people employed at each site and is used to estimate the future distribution of in-migrating workers. Impacts from technologies that would be located at an existing DOE site or that have sites identified as representative locations for analysis purposes were assessed using a site-specific ROI. Technology alternatives for which sites have not been identified, such as the deep borehole, were assessed using a more generic approach.

The most recent data available were used in the socioeconomic analyses. Data were obtained from sources such as the U.S. Bureau of the Census, the BEA, the Federal Bureau of Investigation, the American Medical Association, the American Hospital Association, State and local government publications, and telephone interviews with State and local government officials.

Socioeconomic issues and concerns focus primarily on how changes in the regional economy facilitated by construction and operation of a proposed alternative could affect the demographic composition and economic capacity of the host communities. Proposed alternatives could result in increased employment at potential sites, perhaps leading to population increases and associated changes in demand for community resources. The amount of change depends on the construction and operational requirements of the proposed alternatives and the socioeconomic capacity of the communities in the region where these alternatives may be sited.

New employment opportunities could be created in the regions where proposed alternatives would be located. Generally, the proposed alternatives would directly generate new income and jobs in construction, engineering, sciences, management, and support. Indirect income and job opportunities could also be created as a result of these new jobs to support new demand for goods and services generated from construction and operation activities. These new jobs could be filled by existing available labor in the region, or workers could in-migrate from other areas to fill the jobs. The regions where proposed alternatives are located could benefit economically as a result of an increase in income, and the unemployment rate in the region could fall if new jobs are filled locally.

Increased income and employment opportunities are generally regarded as benefits to many communities. Local businesses gain additional customers, and local governments gain an increase in tax revenues. However, if the attraction of new jobs causes an influx of new workers and their families, this in-migration could overburden the housing market, community services, and infrastructure. Of concern is whether or not communities can absorb this new growth within existing systems or through expansion at a reasonable pace and cost.

The duration of the proposed alternative is an important issue. If the proposed alternative is a large construction effort of short duration with little or no operational employment following, there could be a boom-and-bust effect. Initially, there could be rapid economic expansion and increased demand for housing, community services, and infrastructure. Housing prices may rise, and services and infrastructure may have to be expanded or will become congested beyond capacity. After construction is complete and workers out-migrate to find work elsewhere, unemployment may rise, additional housing vacancies may occur, and expanded community services and infrastructure may be underutilized and more expensive to maintain. Some regions with sophisticated and varied economies can absorb rapid economic expansions and contractions without experiencing significant impacts, but for other communities the boom-and-bust effect could be devastating.

Local transportation discussions characterize the transportation systems in the ROI. The affected environment section describes the locations and general features of the ROI transportation networks, which include road, rail, air, and waterway systems. In addition, current and planned improvements to the road network that will affect access to the site are discussed, as well as public transportation to the site.

General information regarding local transportation modes in the ROI was obtained from local DOT and environmental documents. Roadways to be analyzed for traffic congestion were determined using current employee commuting patterns. Current levels of service designations for these roadways were calculated using information from the DOT, other socioeconomic analyses, and a transportation model designed from the *Highway Capacity Manual #209* equations and factors. This model is used to estimate future baseline No Action projections as well as level of service impacts associated with alternatives.

3.1.9 PUBLIC AND OCCUPATIONAL HEALTH AND SAFETY

Definition of Resources

Public and occupational health and safety issues include the determination of potentially adverse effects on human health and safety that result from acute and chronic exposures to ionizing radiation and hazardous chemicals. The degree of hazard is directly related to the type and quantity of the particular radioactive or chemical material to which the person is exposed and to the duration of this exposure. For normal operations, the exposures have been converted to potential cancers and/or noncancer effects of an acute or a chronic nature. [Text deleted.]

Approach to Defining Environmental Setting

The current radiological and chemical environments at the various sites considered in this PEIS help characterize the setting and serve as a baseline against which impacts associated with the various alternative actions can be compared. Of particular importance are the radiological and hazardous chemical doses that workers and the public receive from exposures associated with both the natural background and existing site operations. These doses may result in health effects. To characterize each site's operational culture, an accident history is presented, past and ongoing health studies of people who work onsite or live in the vicinity are described, and the site's emergency management program is discussed.

Existing site environmental descriptions originate from a series of environmental and radioactive release reports issued annually by DOE sites or sites licensed by the NRC. These reports present the levels of radioactivity and hazardous chemicals in various environmental media (such as air, water, and vegetation) on the site, in the immediate vicinity of the site, and at various distances from the site boundary out to more than 100 km (62 mi). Radiological and chemical doses to individual members of the public and to population groups (including the total population within 80 km [50 mi] of the site) are also given in these reports. The main source of information used to establish existing health impacts to workers, both individual and collective, is the compilation of occupational exposures issued annually by DOE and NRC. Accident histories and the results of epidemiological studies were obtained from many literature sources, including incidence reports and medical journals.

Several methods were used to determine the environmental setting for generic sites. These included the use of regional or national average background radiological and chemical doses and concentrations, the assumption of radiological and chemical doses and concentrations that have been averaged over a number of representative sites; and the presentation of ranges of values associated with representative sites. For a generic borehole site, the current DOE sites proposed in the PEIS adequately bound normal operational radiological and chemical conditions in terms of population density and meteorological conditions; therefore, for the purposes of a generic analysis of the disposition technologies, ranges of conditions are presented. For a generic commercial reactor site, existing normal radiological impacts for representative commercial reactor sites and releases were determined, and a range of results is presented. For a generic commercial MOX fuel fabrication site, normal radiological impacts for representative commercial fuel fabrication sites and their releases were used to establish the range of conditions.

Toxic air pollutants are addressed in both the Air Quality and Noise section and the Public and Occupational Health and Safety section for each of the sites considered in this PEIS. In the air quality section, the maximum concentration of toxic air pollutants at or beyond the site boundary is compared with a Federal, State, or local standard to determine compliance. In the Public and Occupational Health and Safety section, a health risk is calculated based upon chemical concentration and toxicity compared to the RfC for the public and the PEL for workers for noncancer causing chemicals and slope factors for the public and workers for cancer causing chemicals. The cancer effects are a risk that is based on the slope factor (cancer potency) for chemicals that are regulated as carcinogens.

These differences in analytical method result in the different pollutants between the air quality analysis and the public and occupational health analysis. In the air quality analysis, toxic pollutants with low emission rates in most cases will result in extremely low concentrations at the site boundary and therefore are not presented in the air quality analysis. In the public and occupational health analysis, many of these same chemical pollutants may expose an onsite worker located 100 m (328 ft) from the emission source to a health risk and therefore are presented in this analysis. The hazardous chemical pollutants used by these two resource areas to evaluate impacts will be different. Compliance to standards in air quality does not consider what health effects are expected nor the interaction between several chemicals that may together cause health responses even if they separately are at below standard concentrations.

3.1.10 WASTE MANAGEMENT

Definition of Resources

Waste management includes minimization, characterization, treatment, storage, transportation, and disposal of waste generated from ongoing DOE activities. Waste management accepts waste produced by DOE's processing, manufacturing, remediation, D&D, and research activities. The waste is managed using appropriate treatment, storage, and disposal technologies and in compliance with all applicable Federal and State statutes and DOE orders. Appendix E defines the waste categories (high-level, TRU, low-level, mixed, hazardous, and nonhazardous) managed by DOE. Although spent nuclear fuel is not categorized with nuclear waste, it is included in the waste management section of this PEIS, since it is radioactive material that must be stored, managed, and handled. Wastes are generated and categorized by their health hazard and handling requirements. Treated waste is waste that, following generation, has been altered chemically or physically to reduce its toxicity or to prepare it for storage or disposal. Waste treatment can include volume reduction activities, such as incineration or compaction, which may be performed on waste before storage, disposal, or both. Stored waste is waste that, following generation (and usually some treatment), is being retained (temporarily) in a retrievable manner and monitored pending disposal. Disposed waste is waste that has been put in final emplacement to ensure its isolation from the environment and with no intention of retrieval. Deliberate action would be required to regain access to the waste. Disposed wastes include materials placed in a geological repository and buried in landfills.

Approach to Defining Environmental Setting

In order to operate most of its facilities, DOE has entered into numerous agreements with States and EPA to address compliance issues concerning certain aspects of environmental regulatory requirements that have arisen due to either the age of DOE facilities or the uniqueness of DOE operations. For the most part, DOE facilities are in compliance with a major portion of all environmental regulatory requirements, and these compliance agreements address a few specific situations. Appendix E summarizes the applicable Federal statutes and DOE Orders relevant to waste management. In the siting and construction of new facilities, the intent is to meet current regulations; to reach the goal of maximum recycle, minimum waste generation, and no liquid discharges to the surface; and to treat and stabilize unavoidable wastes sufficiently for storage (greater than 90 days) or permanent disposal either onsite or offsite.

Both DOE and the sites maintain waste management databases and publish documents as a reporting mechanism to disclose and gauge progress in meeting environmental regulatory requirements. These databases and reports represent key sources of data that were used for analysis for the waste management resource area. Specific examples include the Waste Management Information System database; the *Integrated Database for U.S. Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics Report*; and the *Mixed Waste Inventory Report*. Other site-specific documents include Annual Waste Minimization and Generation Reports, Site Treatment Plans, Pollution Prevention and Waste Minimization Awareness Plans, Annual Environmental Reports, and Waste Management Plans.

For the generic borehole site, a pristine condition was assumed. For example, no waste generation activities or waste management facilities exist. The generic fuel fabrication facility was compiled from characteristics based on several existing commercial fuel fabricator facilities.

Site-specific data from existing representative LWRs were used to develop a generic existing LWR site. For the generic partially completed reactor, an approach similar to that used for the generic existing LWR site was taken. However, because completion of construction has been deferred, maintenance and limited engineering design work are the only activities. Therefore, only a description of waste management practices that would go into effect once the reactors are operational is provided.

3.2 HANFORD SITE

Hanford, established in 1943 as one of the three original Manhattan Project sites, is located in the State of Washington just north of Richland (see Figures 2.2.1–1 and 2.2.1–2). Hanford was a U.S. Government nuclear materials production site that included nuclear reactor operation, storage and reprocessing of spent nuclear fuel, and management of radioactive and dangerous wastes. Present Hanford programs are diversified and include management of radioactive wastes, R&D for advanced reactors, renewable energy technologies, waste disposal technologies and cleanup of contamination, and Pu stabilization and storage.

Hanford is owned and used primarily by DOE, but small portions of it are owned, leased, or administered by other government agencies. Public access is limited to travel on the Route 4 and Route 10 access roads as far as the Wye Barricade, Highways 24 and 240, and the Columbia River. By restricting access onsite, the public is buffered from the smaller areas formerly used for production of nuclear materials and currently used for waste storage and disposal. Only about 6 percent of the land area has been disturbed and is actively used, leaving mostly open vacant land with widely scattered facilities. The entire Hanford Site has been designated a National Environmental Research Park (NERP).

Hanford includes extensive production, service, research, and development areas. Onsite programmatic and general-purpose facilities total approximately 799,337 m^2 (8,600,000 ft^2) of space. Fifty-one percent (407,658 m^2 [4,390,000 ft^2]) is general-purpose space, including offices, support laboratories, shops, warehouses, and other support facilities. The remaining 391,679 m^2 (4,216,000 ft^2) of space are programmatic facilities comprising processing, evaporation, filtration, waste recovery, waste treatment, waste storage facilities, and R&D laboratories. More than half of the general-purpose and programmatic facilities are more than 30 years old. Facilities designed to perform previous missions are being evaluated for reuse in the cleanup mission (HF DOE 1993c:2). The existing facilities are grouped into the following numbered operational areas (see Figure 2.2.1–2):

- The 100 Areas, located on the southern shore of the Columbia River, are the site of eight retired Pu production reactors and the dual-purpose N Reactor, all of which have been permanently shut down since 1991. The 100 Areas cover about 1,100 ha (2,720 acres).

- The 200 West and 200 East Areas are located on a plateau and are about 8 and 11 km (5 and 7 mi), respectively, south of the Columbia River. Historically, these areas have been dedicated to fuel reprocessing; Pu processing, fabrication, and storage; and waste management and disposal activities. The 200 Areas cover about 1,600 ha (3,950 acres).

- The 300 Area, located just north of the city of Richland, is the site of nuclear and nonnuclear research and development to include the Pacific Northwest Laboratory (PNL). This area covers 150 ha (370 acres).

- The 400 Area, approximately 8 km (5 mi) northwest of the 300 Area, is the location of the recently shut down FFTF and FMEF. FFTF is an advanced liquid metal-cooled research reactor that was used in the testing of breeder reactor systems. FMEF consists of several connected buildings. The six-level Process Building (427 Building) is the main structure of the FMEF and encloses approximately 17,000 m^2 (183,000 ft^2) of operating area. This building has never been operated and is free of contamination. The exterior walls are reinforced concrete, and the cell walls are constructed of high-density concrete. The facility was designed and constructed for spent fuel examination and was subsequently partially converted for MOX fuel fabrication.

- The 600 Area comprises the remainder of Hanford, which includes most of the undisturbed land and has the following key attributes:

- Fitzner-Eberhardt Arid Lands Ecology Reserve (ALE), set aside for ecological studies
- Living sand dunes
- Cultural/historical facilities and sites
- Hanford Reach free-flowing Columbia River
- Old growth sagebrush/habitat areas
- A patrol training facility
- A low-level radioactive waste disposal site, which is leased by the State of Washington and subleased to a commercial enterprise (U.S. Ecology)
- Washington Public Power Supply System (WPPSS) nuclear power plants
- Waste Sampling and Characterization Facility
- Support facilities and infrastructure (for example, roads, railroads, telecommunications, water treatment and distribution, electrical transmission lines/substations, fire/ambulance, and access control facilities, borrow pits, and a landfill)
- DOE waste disposal sites
- A 260-ha (640-acre) parcel of land transferred to the State of Washington as a potential site for a hazardous waste disposal facility
- Meteorological towers and facilities
- A wildlife refuge under revocable use permit to the USFWS
- A recreational game management area under revocable use permit to the State of Washington Department of Fish and Wildlife
- A gravitational-wave observatory, presently under construction

• The 700 Area is the administrative center in downtown Richland and consists of government-owned buildings (for example, the Federal Building).

• The 1100 and 3000 Areas are support areas located in north Richland. The 1100 Area includes support services such as general stores and transportation maintenance. The 3000 Area is being vacated but still contains some administrative and support facilities.

In addition, there are DOE-leased facilities and DOE contractor privately owned facilities, which support Hanford operations, located on private land south of the 300 Area and outside of the 1100 and 3000 Areas (HF PNL 1994b:5).

Department of Energy Activities. The Hanford mission is to clean up the site, provide scientific and technological excellence to meet global needs, and to partner the economic diversification of the region (HF DOE 1994a:3-6). The current DOE activities that support Hanford's mission are shown in Table 3.2–1. In the area of waste management, Hanford has embarked on a long-range cleanup program in compliance with the Hanford Federal Facility Agreement and Consent Order (Tri-Party Agreement) and applicable Federal, State, and local laws. DOE has set a goal of cleaning up Hanford's waste sites and bringing its facilities into compliance with Federal, State, and local environmental laws by the year 2028 (HF PNL 1994b:3). In addition, as part of the cleanup mission, DOE has the responsibility to safely store, handle, and stabilize Pu materials and spent fuel.

Table 3.2–1. Current Missions at Hanford Site

Mission	Description	Sponsor
Waste management	Store defense wastes and handle, store, and dispose of radioactive, hazardous, mixed, or sanitary wastes from current operations	Assistant Secretary for Environmental Management
Environmental restoration	Restore approximately 1,100 inactive radioactive, hazardous, and mixed waste sites and about 100 surplus facilities	Assistant Secretary for Environmental Management
Research and development	Conduct research in the fields of energy, health, safety, environmental sciences, molecular sciences, environmental restoration and waste management research and development, and national security activities	Various DOE Program Managers
Technology development	Develop new technologies for environmental restoration and waste management, including site characterization and assessment methods, and waste minimization	Various DOE Program Managers
Economic transition	Use the cleanup and science and technology mission elements to help the community establish a diversified and stable economic base over the long term	Assistant Secretary for Environmental Management

Source: HF DOE 1994a; HF PNL 1994b.

Non-Department of Energy Activities. In addition to the DOE mission-related activities listed in Table 3.2–1, Hanford has some unique and diverse assets and non-DOE missions, such as the following:

- The Fitzner-Eberhardt ALE Reserve, 31,100 ha (76,800 acres), established in 1967, is managed by Battelle Pacific Northwest Laboratory for DOE with assistance from the Nature Conservancy as a habitat and wildlife reserve and nature research center
- The area north of the Columbia River that is managed in part by the Washington State Department of Wildlife as the Wahluke Slope Wildlife Recreation Area and in part by USFWS as Saddle Mountain National Wildlife Refuge
- The Washington Nuclear Plant–2 (WNP–2) 1,100 MWe reactor operated by WPPSS and also the partially completed WNP–1 reactor
- The Laser Interferometer Gravitational-Wave Observatory, operated by the National Science Foundation as one of two widely separated installations (within the United States) that are operated in unison as a single gravitational-wave observatory
- Hanford Meteorological Station and towers
- An observatory and radio telescope facilities located on Rattlesnake Mountain
- The U.S. Ecology commercial low-level radioactive waste disposal site on State-leased lands near the center of Hanford

3.2.1 LAND RESOURCES

Land Use. The discussion of land resources at Hanford includes land use at Hanford and surrounding area. Hanford encompasses approximately 145,000 ha (358,000 acres) of mostly vacant land in the south-central area of the State of Washington. The land area is relatively flat and dominated by grasses and sagebrush. The Columbia River, which flows through the site, is the area's most important geographical feature. [Text deleted.]

Existing Land Use. Existing generalized land uses at Hanford and its vicinity are shown in Figure 3.2.1–1. All land within Hanford is owned by the Federal Government and is administered and controlled by DOE. Land use in the area southeast of Hanford includes residential, commercial, and industrial development in the Tri-Cities area. This area, encompassing the cities of Richland, Kennewick, and Pasco, is the closest population center and has about 107,000 residents. Agriculture is a major land use in the remaining area surrounding Hanford.

Hanford contains a variety of widely dispersed facilities, including old reactors, R&D facilities, the WPPSS nuclear power facility, consisting of the incomplete WNP-1 reactor and the complete WNP-2 reactor, and various production and processing plants within the specialized operational areas described in Section 3.2. As shown in Figure 3.2.1–1, sensitive open space areas include the Fitzner-Eberhardt ALE Reserve, approximately 31,100 ha (76,800 acres) near Rattlesnake Mountain; and two areas north of the Columbia River: the Saddle Mountain National Wildlife Refuge (12,220 ha [30,200 acres]), which is administered by USFWS, and the Wahluke Unit Columbia Basin Wildlife Area (22,260 ha [55,000 acres]), which is managed by the Washington State Department of Fish and Wildlife (HF NPS 1994a:314,315).

Public access to ALE Reserve and Saddle Mountain National Wildlife Refuge is prohibited (HF DOE 1992b:24,34). Other special status lands within the vicinity include McNary National Wildlife Refuge, administered by USFWS, and Columbia River Islands Area of Critical Environmental Concern (ACEC) and McCoy Canyon, both administered by BLM (Figure 2.2.1–2). McNary National Wildlife Refuge and Columbia River Islands ACEC consist of several islands within the Columbia River that are closed to public access for approximately 6 months of the year (HF NPS 1994a:315,316). The U.S. Department of Agriculture, National Resources Conservation Service does not identify prime farmland on Hanford. However, some soil mapping units have the potential to be prime farmland soils if irrigated (WA USDA 1996a:1).

In 1975, DOE designated the entire Hanford Site area as a NERP, an outdoor laboratory for ecological research to study the environmental effects of energy developments. The Hanford NERP is a sagebrush-steppe habitat that contains a wide range of arid land ecosystems and offers the opportunity to examine linkages between terrestrial, subsurface, and aquatic environments on a systems basis (DOE 1985a:1,3). The closest residence is approximately 30 m (98 ft) from the north Hanford boundary. There is also a mobile home park approximately 60 m (197 ft) from the south boundary.

Land-Use Planning. The DOE Richland Operations Office (RL) has undertaken comprehensive land-use planning to define how best to utilize land at Hanford for the next 30 to 40 years. The December 1994 Secretary of Energy Policy requires RL to manage its land and facilities as valuable national resources. The resulting Comprehensive Land-Use Plan (CLUP) will identify existing and planned future land uses with accompanying restrictions, cover a specific timeframe, and be updated as needed. The development and evaluation of the CLUP will be integrated with the upcoming *Hanford Remedial Action Environmental Impact Statement.* Together, these processes will identify land-use cleanup scenarios, create a remediation baseline for the environmental restoration program, and provide a framework for the future management and utilization of land at Hanford.

Private lands bordering Hanford are subject to the planning regulations of Benton, Franklin, and Grant Counties, and the city of Richland. The majority of Hanford, particularly the site area not reserved as a buffer, is situated within Benton County. Benton County and the city of Richland currently have a comprehensive land-use planning process under way, with statutory mandated deadlines under the State of Washington *Growth*

Management Act (GMA) of 1990. The GMA requires Benton County and the city of Richland to include portions of Hanford in their plans.

The county and city planning could be carried out independently, without any integration with DOE. This would have a significant potential for overlap and duplication, which would result in public confusion as to how the plans relate to each other. To avoid this, RL's integrated CLUP/HRA-EIS process includes coordinating internal organizational and external involvement activities. Tribal Nations, local cities, counties, and State and Federal agencies are voluntarily and cooperatively participating in the preparation of the CLUP to eliminate duplication of efforts and attempt to identify and resolve conflicts early on. A single integrated Geographical Information System data management system is being used to ensure optimum consistency and compatibility among the end products each government agency is developing. The CLUP is scheduled to be implemented by RL in April 1997, after the ROD from the HRA EIS is issued.

Visual Resources. Hanford is located in the Pasco Basin of the Columbia Plateau north of the city of Richland, which is at the confluence of the Yakima and Columbia Rivers. Site topography ranges from generally flat to gently rolling. In the north-central part of the site, two small east-west ridges, Gable Butte and Gable Mountain, rise approximately 60 m (197 ft) and 180 m (591 ft), respectively, above the surrounding terrain. Rattlesnake Hills, Rattlesnake Mountain, Umtanum Ridge, and Yakima Ridge are located along the southwestern and western site boundaries, and the Saddle Mountains are located along the northern site boundary. The Columbia River flows through the northern part of the site and, turning south, forms part of the eastern site boundary. A 79.7-km (49.5-mi) segment of the Columbia River extending downstream from below Priest Rapids Dam to near Johnson Island (river mile 346.5 to 396) is currently protected and is part of a Proposed Action designating this segment of the Hanford Reach as a Wild and Scenic River (HF NPS 1994a:5,62,311). The Yakima River runs along a small portion of the southern site boundary (Figure 3.2.1–1).

The site is dominated by widely spaced low brush and grasslands, typical of the regional shrub-steppe desert. A large area of unvegetated mobile sand dunes is located along the eastern site boundary, and unvegetated blowouts are scattered throughout the site. Hanford consists mostly of undeveloped land, with widely spaced clusters of industrial buildings located along the southern and western banks of the Columbia River and at several interior locations. The WPPSS nuclear power facility is also located along the west bank of the Columbia River. The adjacent visual landscape consists mainly of rural rangeland and farms; the city of Richland, part of the Tri-Cities area, is the only adjoining urban area. Construction and operation of the DOE and WPPSS facilities have disturbed the character of the landscape within their respective areas. The DOE and WPPSS facilities are brightly lit at night and highly visible from many areas. The plume of steam that rises high into the air at the WPPSS facility is also highly visible from the surrounding area, including portions of the Tri-Cities area. The developed areas of Hanford are consistent with a VRM Class 5 designation. The remainder of the site ranges from a VRM Class 3 to Class 4 designation.

Viewpoints affected by DOE and WPPSS facilities are primarily associated with the public access roadways (including State Highways 24 and 240, Hanford Road, Horn Rapids Road, and Route 4 South/Stevens Drive), the bluffs along the east bank of the Columbia River, and the north edge of the city of Richland. Views of DOE facilities from the surface of the Columbia River are generally blocked by high river banks; however, stack plumes from the WPPSS facility are visible. Because of the semi-arid climate, views can exceed 80 km (50 mi); however, topographic relief provides significant visual screening of the Hanford facilities.

The most sensitive visual areas include the Columbia River, because of its potential designation as a Wild and Scenic River, and the northern part of the city of Richland that borders the site, because of the high-density commercial and residential land use. Route 4 South/Stevens Drive is the only affected public access roadway with high traffic volumes. However, since this route primarily serves the DOE and WPPSS facilities, user sensitivity is low. Although some facilities are visible from the east bank of the Columbia River, densities are low and, in most instances, the viewing distances are great.

3.2.2 SITE INFRASTRUCTURE

Baseline Characteristics. Activities at Hanford are concentrated at facilities in several general areas previously described in Section 3.2. To support these missions, an extensive infrastructure exists. Baseline site infrastructure characteristics are shown in Table 3.2.2–1.

Table 3.2.2–1. Hanford Site Baseline Characteristics

Characteristics	Current Usage	Site Availability
Transportation		
Roads (km)	420	420
Railroads (km)	204	204
Electrical		
Energy consumption (MWh/yr)	345,500	1,678,700
Peak load (MWe)	58	281
Fuel		
Natural gas (m^3/yr)	459,200	20,804,000
Oil and propane (l/yr)	9,334,800	14,775,000
Coal (t/yr)	41,580	91,708
Steam (kg/hr)	40,847	40,847

Source: HF DOE 1990e.

The site infrastructure provides for transportation of personnel and most material shipments by road. Bulk materials (primarily coal), large equipment, irradiated fuel, and radioactive solid and liquid wastes are transported by rail. High-level and low-level liquid radioactive wastes from past process operations are transported between waste management facilities by encased pipeline. Large barged shipments (decommissioned submarine reactor cores) are routinely offloaded at the Port of Benton dock facility (on the Columbia River in north Richland) and transported to a site disposal facility using special multiwheeled trailers.

Hanford has a network of paved roads. Only 104 km of the 420 km (65 of 261 mi) of these roads are accessible to the public. Hanford is also crossed by State Route 240, which is the main route traveled by the public. Most onsite employee travel is on Route 4, the primary highway from the Tri-Cities to most Hanford outer area work locations. A recently constructed access road between State Route 240 and the 200 West Area has alleviated peak traffic congestion on Route 4. Access to the outer areas (100 and 200 Areas) is controlled by DOE at the Yakima, Wye, and the new Rattlesnake barricades.

Onsite rail transport is provided by a short-line railroad owned by DOE, which controls all access. Hanford's railroad is a Class III Railroad System, as defined by the Federal Railroad Administration. Its common carrier tie is with the Union Pacific Railroad in Richland. A series of maintenance upgrades to the site's main trackage was completed in 1994. The Hanford railroad will continue to support site cleanup in a variety of ways, such as transporting liquid waste, contaminated soils, construction materials, spent nuclear fuel, large equipment, and closure materials.

Electricity, the only regional utility service supplied to Hanford, is provided by the Bonneville Power Administration (BPA). A site electrical transmission and distribution system is used to provide power to the majority of Hanford. The city of Richland distributes power for about 3 percent of the total site usage. Hanford is a Priority Firm customer, and the BPA is contractually obligated to provide as much power as the site requires. Being a Priority Firm customer ensures that, in the event of severe regional power shortages, Hanford (along with other Priority Firm customers) would be the last level of BPA service to be shut off. Power to the BPA grid is dominated by hydropower (more than 70 percent), which provides a typically reliable source of power.

Hydropower is normally more constrained by seasonal variation in peak demand than in meeting momentary peak demand levels. The Northwest Sub-Regional Power Pool capabilities are shown in Table 3.2.2–2.

Natural gas, provided by the Cascade Natural Gas Corporation, is currently used in a few locations on Hanford. Fuel oil and propane are also used in some areas. Coal is currently used to fuel the 200 East Area central steam plant, which also supplies steam to the 200 West Area. The steam system (production and distribution) in the 200 Areas was built in the 1940s, and upgrade and replacement are required to maintain reliability. Natural gas, in conjunction with distributed package boilers, is planned for alternative steam production and heating systems. These improvements are planned for 1996.

Table 3.2.2–2. Northwest Sub-Regional Power Pool Electrical Summary

Characteristics	Energy Production
Type Fuel[a]	
Coal	34%
Nuclear	3%
Hydro/geothermal	46%
Oil/gas	7%
Other[b]	11%
Total Annual Production	256,404,000 MWh
Total Annual Load	250,045,000 MWh
Energy Exported Annually	6,359,000 MWh
Generating Capacity	49,596 MWe
Peak Demand	33,325 MWe
Capacity Margin[c]	13,655 MWe

[a] Percentages do not total 100 percent due to rounding.
[b] Includes power from both utility and nonutility sources.
[c] Capacity margin is the amount of generating capacity available to provide for scheduled maintenance, emergency outages, system operating requirements, and unforeseen electrical demand.
Source: NERC 1993a.

The Columbia River is the primary source of raw water for Hanford. The average annual river flow through the site is approximately 203 million l/minute (min) (50 million gal/min). The Export Water System, with a capacity of 124,900 l/min (33,000 gal/min), serves the 200 Areas and most of the shutdown 100 (reactor) Areas. The 100 K East and K West Areas have an independent river source. Wells supply water to the 400 Area and a variety of low-use facilities at remote locations. The administrative and research areas in north Richland are supplied with water by the city of Richland.

Most of the weapons-usable Pu at Hanford is stored in the PFP. The PFP is a group of buildings located in an enhanced security portion of 200 West Area around the 234-5Z Building. The total area (all levels) is approximately 25,000 m^2 (270,000 ft^2), including processing and all service/support space.

The PFP complex includes the following: Pu processing systems in gloveboxes and cells, HVAC systems (some with multiple stages of HEPA filtration), analytical laboratory, developmental laboratory, maintenance shops, administrative offices; security features, and fire suppression systems. Additional services, such as fire protection, medical services, security support, steam, water, and electrical power, are provided to the PFP from site services. [Text deleted.]

The original purpose of the PFP was to convert Pu nitrate into metal ingots and weapons components. The facility is essentially self-sustaining; its process capability is supported by scrap recycle capability, Pu storage, and maintenance/repair facilities. The 234-5Z Building has no identified future missions beyond Pu stabilization and is programmed for D&D. The newer 2736-Z Pu storage vault and two ancillary structures are located immediately south of the 234-5Z Building and provide 8,224 storage spaces for Pu. This facility will continue to be utilized for Pu storage until new facilities are constructed or the Pu is shipped offsite. Approximately 25 percent of 2736-Z has been dedicated as a vault where Pu material can be stored under IAEA surveillance.

The ROD resulting from the *Plutonium Finishing Plant Stabilization Final Environmental Impact Statement* (DOE/EIS-0244-F) decided to remove Pu material in holdup in the PFP and stabilize the holdup and other Pu-bearing material at the PFP. Following stabilization, Pu will be in a form suitable for interim storage in existing vaults at the PFP Facility. Low Pu content material could be treated to meet WIPP Waste Acceptance Criteria.

Another existing facility complex at Hanford that could be used to store or process Pu is the FMEF. The FMEF consists of several connected buildings located in the 400 Area. The six-level Process Building (427 Building), the main structure of the facility, has an attached single-level mechanical wing on the west side and an emergency power wing at the northwest corner. The Process Building encloses approximately 17,650 m^2 (190,000 ft^2) of operating area and extends from 30 m (100 ft) above grade to about 11 m (36 ft) below grade. This building has never been operated and is free of contamination. The exterior walls are made of reinforced concrete 0.3 m (1.0 ft) thick and the cell walls are constructed of high-density concrete 1.2 m (4.0 ft) thick. Some of the walls within the facility are used as both load-bearing and radiation-shielding walls. In some locations, high-density concrete is used for cell-shielding walls because of specific shielding requirements. The other building within the FMEF complex is a two-level building (4682 Building), which is connected to the south side of the Process Building. The 4682 Building is divided into two portions: (1) the administrative portion known as the entry wing and (2) the shop portion, which was designed to house the Fuel Assembly Area for fabrication of MOX fuel and test assemblies for the FFTF.

3.2.3 AIR QUALITY AND NOISE

Meteorology and Climatology. The climate at Hanford and in the surrounding region is characteristically that of a semiarid steppe. The humidity is low, and winters are mild. The average annual temperature is 11.8 °C (53.3 °F); average monthly temperatures range from a minimum of -1.5 °C (29.3 °F) in January to a maximum of 24.7 °C (76.5 °F) in July. The average annual precipitation is 16.0 cm (6.3 in). The prevailing winds at Hanford are from the northwest. The average annual windspeed is 3.4 m/second (s) (7.6 miles per hour [mph]) (HF PNL 1994b:83-84). Additional information related to meteorology and climatology at Hanford is presented in Appendix F.

Ambient Air Quality. Most of Hanford is located within the South-Central Washington Intrastate Control AQCR (#230) with a small portion of the site being located in the Eastern Washington-Northern Idaho Interstate AQCR (#62). None of the areas within Hanford and its surrounding counties are designated as a nonattainment area (40 CFR 81.348) with respect to NAAQS for criteria pollutants (40 CFR 50). Applicable NAAQS and Washington Ambient Air Quality Standards are presented in Appendix F.

Four PSD (40 CFR 52.21) Class I areas have been designated in the vicinity of Hanford: Goat Rocks Wilderness Area, located 145 km (90 mi) west of the site; Mount Rainier National Park, located 160 km (99 mi) west of the site; Mount Adams Wilderness Area, located 153 km (95 mi) southwest of the site; and Alpine Lakes Wilderness Area, located 177 km (110 mi) northwest of the site.

Since the creation of the PSD program in 1977, permits were obtained for nitrogen dioxide (NO_2) emissions from Pu-uranium extraction and uranium oxide plants located in the 200 Area. The maximum increases in the annual NO_2 concentration at the Hanford boundary were estimated to be negligible (Table 3.2.3-1).

Ambient air quality within and near the Hanford boundary is currently monitored for NO_2 and particulate matter. The ambient air quality data collected during the last few years are either very small percentages of the limits set in applicable ambient standards (sulfur dioxide [SO_2] and carbon monoxide [CO]) or substantially lower than the limits set in applicable ambient standards.

At Hanford, the major sources of criteria air pollutants (pollutants for which a NAAQS has been written including PM_{10}, SO_2, NO_2, CO, ozone [O_3], and lead [Pb]) are coal-burning boilers and fugitive coal piles. Other emissions include other process emissions, vehicular emissions, and temporary emissions from various construction activities. Most of the process emissions at Hanford will have been discontinued, and space heating requirements will be met by burning natural gas by 2005 as reflected in the No Action emissions presented in Appendix F.

Table 3.2.3–1 presents the baseline ambient air concentrations for criteria pollutants and other pollutants of concern at Hanford. As shown in the table, baseline concentrations are in compliance with applicable guidelines and regulations.

Noise. The major noise sources within Hanford include various facilities, equipment, and machines (for example, cooling systems, transformers, engines, pumps, boilers, steam vents, paging systems, construction and materials handling equipment, and vehicles). Data from two noise surveys indicate that background noise levels (measured as 24-hour equivalent sound level) at Hanford range from 30 to 60.5 dBA (Appendix F). The 24-hour background sound level at undeveloped areas at Hanford ranges from 24 to 36 dBA, except when high winds elevate sound levels (HF PNL 1994a:4.145). The primary source of noise at the site and nearby residences is traffic. Most Hanford industrial facilities are at a sufficient distance from the site boundary that noise levels at the boundary from these sources are not measurable or are barely distinguishable from background noise levels.

The State of Washington has established noise standards for different source and receptor areas. Hanford belongs to source area Class C (industrial). The maximum allowable noise level for residential, commercial, and

Table 3.2.3–1. Comparison of Baseline Ambient Air Concentrations With Most Stringent Applicable Regulations or Guidelines at Hanford Site, 1994

Pollutant	Averaging Time	Most Stringent Regulation or Guideline[a] (μg/m³)	Baseline Concentration (μg/m³)
Criteria Pollutants			
Carbon monoxide	8-hour	10,000[b]	0.7
	1-hour	40,000[b]	2.6
Lead	Calendar Quarter	1.5[b]	<0.01
	24-hour	0.5[c]	<0.01
Nitrogen dioxide	Annual	100[b]	0.2
Ozone	1-hour	235[b]	[d]
Particulate matter less than or equal to 10 microns in diameter	Annual	50[b]	0.01
	24-hour	150[b]	0.1
Sulfur dioxide	Annual	52[c]	0.8
	24-hour	260[c]	6.6
	3-hour	1,300[b]	22.9
	1-hour	1,018[c]	47.9
	1-hour	655[c,e]	47.9
Mandated by the State of Washington			
Gaseous fluoride	30-day	0.8[c]	[f]
	7-day	1.7[c]	[f]
	24-hour	2.9[c]	[f]
	12-hour	3.7[c]	[f]
Total suspended particulates	Annual	60[c]	0.01
	24-hour	150[c]	0.1
Hazardous and Other Toxic Compounds			
Arsenic	Annual	0.00023[c,g]	0.00019
Cadmium	Annual	0.00056[c,g]	0.00008
Chromium	24-hour	1.7[c,g]	0.0029
Copper	24-hour	3.3[c,g]	0.0018
Formaldehyde	Annual	0.077[c,g]	0.00017
Manganese	24-hour	0.4[c,g]	0.0040
Nickel	Annual	0.0021[c,g]	0.00097
Polycyclic organic matter	24-hour	[h]	0.19
Selenium	24-hour	0.67[c,g]	0.00036
Vanadium	24-hour	0.17[c,g]	0.010

[a] The more stringent of the Federal and State standards is presented if both exist for the averaging time.
[b] Federal and State standard.
[c] State standard.
[d] Ozone, as a criteria pollutant, is not directly emitted or monitored by the site. See Section 4.1.3 for a discussion of ozone-related issues.
[e] The standard is not to be exceeded more than twice in any seven consecutive days.
[f] No sources of the pollutant have been identified.
[g] Risk-based acceptable source impact levels.
[h] No State standard for indicated averaging time.
Source: 40 CFR 50; HF 1995a:1; WA Ecology 1994a.

industrial receptor areas is 50 to 70 dBA (Appendix F). Hanford is currently in compliance with State and Federal noise regulations.

3.2.4 WATER RESOURCES

Surface Water. Major surface water features at Hanford are the Columbia River (northern and eastern sections), the Yakima River, springs along the Columbia River and on Rattlesnake Mountain, and onsite ponds (Figure 3.2.4–1).

The flow of the Columbia River is regulated by 11 dams within the United States, 7 upstream and 4 downstream of the site (HF PNL 1994a:4.40). Located approximately 10 km (6.2 mi) upstream of Hanford, the Priest Rapids Dam is the nearest dam, while McNary is the nearest dam downstream (80 km [50 mi]). The portion of the Columbia River between these dams is referred to as the Hanford Reach. Flows through the Hanford Reach fluctuate significantly and are controlled primarily by operations at Priest Rapids Dam. The annual average flow rate in the vicinity of Priest Rapids Dam is approximately 3,360 cubic meters (m^3)/s (118,642 cubic feet [ft^3]/s) (HF PNL 1994a:4.40).

The Yakima River, bordering a short length of the southern portion of Hanford, has a low annual flow rate compared to the Columbia River (HF PNL 1994a:4.42). The average annual flow rate is about 104 m^3/s (3,673 ft^3/s). Approximately one-third of Hanford is drained by the Yakima River System.

Rattlesnake Springs and Snively Springs, located on the western part of Hanford, form small surface streams. Rattlesnake Springs flows for about 3 km (1.9 mi) before disappearing into the ground (Figure 3.2.4–1). Cold Creek and its tributary, Dry Creek, are ephemeral streams located in the southern portion of Hanford (HF PNL 1994a:4.42). These streams drain areas to the west of Hanford and cross the southwestern part of the site toward the Yakima River. Surface flow, when it occurs, infiltrates rapidly and disappears into the surface sediments in the western part of the site.

The primary uses of the Columbia River include the production of hydroelectric power, transportation, and extensive irrigation in the Mid-Columbia Basin (HF PNL 1994a:4.40). Another principle use of the river is by the fishery industry. Several communities located along the Columbia River rely on the river as their source of drinking water and for recreational purposes. Water from the Columbia River along the Hanford Reach is also used as a source of drinking water by several onsite facilities and for industrial uses.

Large Columbia River floods have occurred in the past, but the likelihood of recurrence of large-scale flooding has been reduced by the construction of several flood-control and water-storage dams upstream of the site (HF PNL 1994a:4.42). Major floods on the Columbia River are typically the result of rapid melting of the winter snowpack over a wide area augmented by above-normal precipitation. The largest flood on record occurred June 7, 1894, with a peak discharge at Hanford of 21,000 m^3/s (741,615 ft^3/s). The floodplain associated with the 1894 flood was limited to within approximately 3 km (1.9 mi) of the banks of the river. The largest recent flood took place in 1948, with an observed peak discharge of 20,000 m^3/s (706,300 ft^3/s) at Hanford. The probability of flooding at the magnitude of the 1894 and 1948 floods has been greatly reduced because of upstream regulation by dams (HF PNL 1994a:4.42).

Major flooding of the Yakima River, which has occurred several times this century, could extend into a small portion of the southern section of Hanford, but the upstream Yakima River is physically separated from Hanford by Rattlesnake Mountain, which would prevent major flooding on Hanford (HF PNL 1994a:4.43). There are no Federal Emergency Management Agency (FEMA) floodplain maps for the Hanford Reach of the Columbia River. FEMA only maps developing areas, and the Hanford Reach is specifically excluded.

Surface Water Quality. The State of Washington has classified the stretch of the Columbia River from Grand Coulee to the Washington-Oregon border, which includes the Hanford Reach, as Class A, excellent raw drinking water, recreation area, and wildlife habitat. The Columbia River is currently in compliance with applicable State and Federal drinking water standards (HF PNL 1994a:4.58).

Water samples have been collected periodically from the Hanford Reach of the Columbia River. Radionuclides consistently detected in the river during 1993 were iodine-129 (I-129), strontium-90 (Sr-90), tritium, U-234, and uranium-238 (U-238). In addition, technetium-99 (Tc-99), U-238, and Pu-239/240 were detected in 50 percent or more of the samples analyzed during the year. Total alpha and beta measurements were similar to previous years and were approximately 5 percent or less of the applicable drinking water standards of 15 and 50 picocuries (pCi)/l (4 pCi/gal and 13.2 pCi/gal), respectively. These measurements are useful indicators of the general radiological quality of the river and, because results are obtained quickly, provide an early indication of changes in radioactive contamination levels. Tritium measurements at Richland were all well below State and Federal drinking water standards. All nonradiological water quality standards were met for Class A-designated water (HF PNL 1994a:4.58). Surface water quality data downstream of Hanford are presented in Table 3.2.4–1.

Surface Water Rights and Permits. The Department has asserted, and continues to assert, a federally reserved water withdrawal right to obtain water from the Columbia River. Currently, Hanford withdraws approximately 13.5 billion l/yr (3.57 billion gal/yr) of water from the Columbia River.

Groundwater. Groundwater under Hanford occurs in unconfined and confined aquifers. The unconfined aquifer lies within the boundaries of the Pasco Basin contained within glaciofluvial sands and gravels of the Hanford Formation as well as the fluvial and lacustrine sediments of the Ringold Formation. Across the site, groundwater generally flows easterly through sands and gravels of the middle member of the Ringold Formation of the unconfined aquifer. The base of the aquifer is the Columbia River Basalt or, in some areas, the clay zones of the lower member of the Ringold Formation. The aquifer thickness ranges from 15 to 61 m (49 to 200 ft), where it thins along the flanks of bordering structures. As a result of local water disposal to surface ponds, the water table has risen as much as 27 m (89 ft) in the 200 West Area (HF PNL 1994a:4.54). This has caused groundwater mounding, including radial and northward flow components, in the 200 Areas. Depth to groundwater ranges from approximately 24 to 80 m (79 to 262 ft) across Hanford. Figure 3.2.4–2 shows the water table elevations and the direction of groundwater movement.

The unconfined aquifer is recharged from rainfall and runoff from higher bordering elevations to the west, water infiltrating from small ephemeral streams, river water along influent reaches of the Yakima and Columbia Rivers, and upward leakage from the lower confined aquifers and from artificial recharge (agricultural irrigation and waste disposal operations at Hanford). In the Hanford vicinity, groundwater is discharged primarily along the Columbia River, with lesser amounts going to the Yakima River (HF PNL 1994a:4.52).

The confined aquifers at Hanford consist of sedimentary interbeds and interflow zones that occur between basalt flows in the Columbia River Basalt Group. Main water-bearing portions of the interflow zones occur within a network of interconnecting vesicles and fractures of the flow tops or flow bottoms. The confined aquifers are continuous throughout most of the Pasco Basin except where the aquifers have been eroded or stratigraphically pinched out. The thickness of these aquifers varies from several centimeters to at least 52 m (171 ft). Recharge of the confined aquifer occurs primarily where the basalt formations are at or near ground levels as water infiltrates from precipitation and stream runoff at areas including the Rattlesnake Hills, Yakima Ridge, Umtanum Ridge, and the Saddle Mountains. Groundwater from these confined aquifers is also discharged to the Columbia River (HF PNL 1994a:4.91).

Groundwater Quality. Groundwater quality at Hanford has been affected by liquid waste released to the soil column by past and ongoing site operations. [Text deleted.] Minor quantities of the longest-lived radionuclides have reached the water table via a failed groundwater monitoring well casing and through reverse well injection, a disposal practice that was discontinued at Hanford in 1947. The unconfined aquifer contains both radiological and nonradiological contaminants at concentrations exceeding water quality criteria and standards. Table 3.2.4–2 shows the unconfined groundwater quality at Hanford. Tritium and I-129 have been detected in the confined aquifer. Contamination in the confined aquifer, however, is typically limited to areas where there is exchange with the unconfined aquifer (HF PNL 1994a:4.52).

Table 3.2.4–1. Summary of Columbia River Surface Water Quality Monitoring at Hanford Site (Richland Pumphouse), 1993

			Concentration[a]	
Parameter	**Unit of Measure**	**Water Quality Criteria and Standards[b]**	**High**	**Low**
Alpha (gross)	pCi/l	15[c]	1.69	$<1.18\times10^{-3}$
Barium	mg/l	2[c]	0.036	0.029
Beta (gross)	pCi/l	50[d]	2.8	NR
Calcium	mg/l	NA	22.1	17.0
Chloride	mg/l	250[e]	1.2	1.01
Chromium	mg/l	0.1[c]	$<2.0\times10^{-2}$	5.4×10^{-3}
Copper	mg/l	1.0[c]	0.0033	<0.002
Fluoride	mg/l	4[c], 2[e]	0.3	0.1
Iodine-129	pCi/l	20[f]	0.00014	NR
Iron	mg/l	0.3[e]	0.0673	0.034
Magnesium	mg/l	NA	5.367	4.055
Manganese	mg/l	0.05[e]	0.0071	<0.0014
Nitrate	mg/l	10[c]	0.58	0.35
pH	pH units	6.5-8.5[e]	8.6	8.1
Potassium	mg/l	NA	1.225	0.087
Plutonium-239/240	pCi/l	1.2[f]	7.82×10^{-5}	$<3.25\times10^{-6}$
Sodium	mg/l	NA	2.83	2.436
Strontium-90	pCi/l	400[f]	1.37×10^{-1}	$<2.39\times10^{-2}$
Sulfate	mg/l	250[e]	11.6	8.2
Technetium-99	pCi/l	4,000[f]	0.25	NR
Tritium	pCi/l	80,000[f]	162	48.6
Uranium-234	pCi/l	20[f]	3.56×10^{-1}	1.89×10^{-1}
Uranium-235	pCi/l	24[f]	2.20×10^{-2}	$<-5.05\times10^{-4}$
Uranium-238	pCi/l	24[f]	3.19×10^{-1}	1.44×10^{-1}
Zinc	mg/l	5[e]	<0.02	<0.0026

[a] Data are average values from four separate sampling events.
[b] For comparison purposes only.
[c] National Primary Drinking Water Regulations (40 CFR 141).
[d] Proposed National Primary Drinking Water Regulations: Radionuclides (56 FR 33050).
[e] National Secondary Drinking Water Regulations (40 CFR 143).
[f] DOE Derived Concentration Guides (DCG) for water (DOE Order 5400.5), DCG values are based on a committed effective dose of 100 mrem per year; however, because the drinking water maximum contaminant level is based on 4 mrem per year, the number listed is 4 percent of DCG. All concentrations of radionuclides are determined by subtracting the instrument background environmental level from the monitored location. A negative or zero incremental concentration means that the concentration at the sampling location is equivalent to the background environmental level.

Note: mg/l=milligrams per liter; pCi/l=picocuries per liter; NA=not applicable; NR=not reported.

Source: HF PNL 1994a.

Tritium and nitrate plumes have been identified in the unconfined aquifer at Hanford. Because both are ubiquitous in liquid waste streams and are highly mobile in groundwater, they can be used as good indicators of the extent of groundwater contamination at Hanford. The major plume of tritium-contaminated groundwater has continued to move eastward over the years and has seeped into the Columbia River (HF PNL 1992a:157). The generalized locations of the major plumes are shown on Figure 3.2.4–2.

Groundwater Availability, Use, and Rights. Groundwater in the Pasco Basin area is used for domestic, industrial, and agricultural purposes. The principal groundwater users within Hanford are the FFTF, the PNL, and remote

Table 3.2.4–2. Groundwater Quality Monitoring in the Unconfined Aquifer at Hanford Site, 1993

Parameter	Unit of Measure	Water Quality Criteria and Standards[a]	Existing Conditions 1993 High	Existing Conditions 1993 Low
1,2-Dichloroethylene	mg/l	0.007[b]	180	<dL
Carbon tetrachloride	mg/l	0.005[b]	7	<dL
Cesium-137	pCi/l	120[c]	2,087[d]	<dL
Chromium	mg/l	0.1[b]	19.1	<dL
Cobalt-60	pCi/l	400[c]	423	<dL
Iodine-129	pCi/l	20[c]	64.2	<dL
Nitrate	mg/l	10[b]	870	<dL
Plutonium-239/240	pCi/l	1.2[c]	125[d]	<dL
Strontium-90	pCi/l	400[c]	7,890[e]	<dL
Technetium-99	pCi/l	4,000[c]	20,500[f]	<dL
Tetrachloroethylene	mg/l	0.005[b]	0.0059	<dL
Trichloroethylene	mg/l	0.005[b]	0.061	<dL
Tritium	pCi/l	80,000[c]	3,590,000[g]	<dL
Uranium, Total	mg/l	0.02[h]	3,320[i]	<dL

[a] For comparison purposes only.
[b] National Primary Drinking Water Regulations (40 CFR 141).
[c] DOE DCG for water (DOE Order 5400.5). DCG values are based on a committed effective dose of 100 mrem per year; however, because the drinking water maximum containment level is based on 4 mrem per year, the number listed is 4 percent of the DCG.
[d] Found in well 299-E28-25.
[e] Found in well 299-E28-23.
[f] Found in well 299-W19-24.
[g] Found in well 299-E17-9.
[h] Proposed National Primary Drinking Water Regulations, Radionuclides (56 FR 33050).
[i] Found in well 299-W19-29.
Note: dL=detection limit.
Source: HF PNL 1994c.

training and laboratory facilities. Currently, DOE asserts a federally reserved water withdrawal right with respect to its existing Hanford operations and withdraws approximately 195 million l/yr (51.6 million gal/yr).

3.2.5 GEOLOGY AND SOILS

Geology. Hanford is located in a portion of the Pasco Basin, a topographic and structural depression in the southwest corner of the Columbia Basin physiographic subprovince. The Columbia Basin is a subprovince of the Columbia Intermontane physiographic province and is characterized by generally low-relief hills with incised river drainages. The Columbia Plateau is that portion of the Columbia Intermontane physiographic province that is underlain by the Columbia River Basalt Group and includes the Columbia Basin (HF PNL 1994a:4.20). The site is bounded on the west, southwest, and north by anticlinal ridges that trend eastward from the Cascade Mountains; on the east by the Columbia River with its steep, west-facing white bluffs; and on the southeast by the confluence of the Yakima and Columbia Rivers.

The stratigraphy of Hanford consists of Miocene-age and younger rocks which overlay older Cenozoic sedimentary and volcaniclastic basement rock. The major geologic units underlying Hanford are, in ascending order: subbasalt (basement) rocks, the Columbia River Basalt Group, the Ellenburg Formation, the Ringold Formation, the Plio-Pleistocene unit, early "Palouse" soil, and the Hanford Formation.

The Pasco Basin is filled with greater than 3 km (1.8 mi) of basalt of the Columbia River Basalt Group that overlies probable metasedimentary and metavolcanic rocks intruded by Mesozoic granitic rocks (HF DOE 1995g:4-7). The Columbia River Basalt Group consists of an accumulation of Eocene- to Pliocene-age basalt flows emitted concurrently with basin subsidence. Within and overlying the basalt sequence are tuffs and tuffaceous sediments of the Ellenburg Formation. This unit is overlain by the Mio-Pliocene Ringold Formation, a sequence of fluvial-lacustrine gravels and sands and floodplain silts and clays. These sediments were deposited by the ancestral Columbia River and its tributaries that flowed across the Pasco Basin after volcanic activity ceased. The upper part of the Ringold Formation is represented by an approximately 12-m (40-ft) bed in the western part of Hanford. The Plio-Pleistocene unit is a locally derived unit consisting of a sidestream alluvium and/or pedogenic calcrete and occurs at the unconformity between the Ringold Formation and the Hanford Formation (HF PNL 1994a:4.27). Overlying this unit in the Cold Creek syncline area is an aeolian silt and fine grained sand (early "Palouse" soil).

The tertiary sediments and basalts were locally eroded and truncated by a sequence of gigantic floods that took place within the past 100,000 years. These floods formed a channeled scabland that crosses the central and northeastern part of Hanford. This flooding deposited as much as 162 m (532 ft) of sands, gravels (Pasco Gravel), and clays (Touchet Beds) of the Hanford Formation. These units are, in turn, overlain by Holocene aeolian, alluvial, and landslide deposits interbedded with three to four thin, regional ash falls. Tectonic activity has continued through the Holocene, as evidenced by progressive warping of the Ringold Formation, decreasing upward through the section, and tilting of the Touchet Beds.

Hanford lies on the Hanford alluvial plain. Basalt outcrops are exposed on anticlinal ridges at Gable Mountain, Gable Butte, and the Saddle Mountains in the northern part of the reservation and on Rattlesnake Hills and Yakima Ridge, overlapping the western and southwestern edges of the reservation. Other than gravel, no economically viable geologic resources have been identified at Hanford.

The Modified Mercalli Intensity (MMI) scale, which evaluates earthquake intensity, and the Richter scale, which measures an earthquake's magnitude and energy, are both used to assess potential earthquake risk. Table 3.2.5–1 illustrates the approximate correlation between the MMI scale, the Richter scale, and maximum ground acceleration.

According to the 1994 Uniform Building Code, Hanford is in seismic zone 2B (ICBO 1994a). However, for this PEIS, Uniform Building Code Seismic Zones 2A and 2B were consolidated into Seismic Zone 2 (Figure 3.2.5–1). Seismic Zones 2A and 2B differ only in that Seismic Zone 2B represents the potential for slightly more damage than 2A corresponding to an earthquake intensity VII on the MMI scale.

Table 3.2.5–1. The Modified Mercalli Intensity Scale of 1931, With Approximate Correlations to Richter Scale and Maximum Ground Acceleration[a]

Modified Mercalli Intensity[b]	Observed Effects of Earthquake	Approximate Richter Magnitude[c]	Maximum Ground Acceleration[d]
I	Usually not felt	<2	negligible
II	Felt by persons at rest, on upper floors or favorably placed	2-3	<0.003 G
III	Felt indoors; hanging objects swing; vibration like passing of light truck occurs; might not be recognized as earthquake	3	0.003 to 0.007 G
IV	Felt noticeably by persons indoors, especially in upper floors; vibration occurs like passing of heavy truck; jolting sensation; standing automobiles rock; windows, dishes, and doors rattle; wooden walls and frames may creak	4	0.007 to 0.015 G
V	Felt by nearly everyone; sleepers awaken; liquids disturbed and may spill; some dishes break; small unstable objects are displaced or upset; doors swing; shutters and pictures move; pendulum clocks stop or start		0.015 to 0.03 G
VI	Felt by all; many are frightened; persons walk unsteadily; windows and dishes break; objects fall off shelves and pictures fall off walls; furniture moves or overturns; weak masonry cracks; small bells ring; trees and bushes shake	5	0.03 to 0.09 G
VII	Difficult to stand; noticed by car drivers; furniture breaks; damage moderate in well built ordinary structures; poor quality masonry cracks and breaks; chimneys break at roof line; loose bricks, stones, and tiles fall; waves appear on ponds and water is turbid with mud; small earthslides; large bells ring	6	0.07 to 0.22 G
VIII	Automobile steering affected; some walls fall; twisting and falling of chimneys, stacks, and towers; frame houses shift if on unsecured foundations; damage slight in specially designed structures, considerable in ordinary substantial buildings; changes in flow of wells or springs; cracks appear in wet ground and steep slopes		0.15 to 0.3 G
IX	General panic; masonry heavily damaged or destroyed; foundations damaged; serious damage to frame structures, dams and reservoirs; underground pipes break; conspicuous ground cracks	7	0.3 to 0.7 G
X	Most masonry and frame structures destroyed; some well built wooden structures and bridges destroyed; serious damage to dams and dikes; large landslides; rails bent	8	0.45 to 1.5 G
XI	Rails bent greatly; underground pipelines completely out of service		0.5 to 3 G
XII	Damage nearly total; large rock masses displaced; objects thrown into air; lines of sight distorted	9	0.5 to 7 G

[a] This table illustrates the approximate correlation between the MMI scale, the Richter scale, and maximum ground acceleration.
[b] Intensity is a unitless expression of observed effects.
[c] Magnitude is an exponential function of seismic wave amplitude, related to the energy released.
[d] Acceleration is expressed in relation to the earth's gravitational acceleration (G).
Source: ICSSC 1985a; PPI 1994a.

Seismicity of the Columbia Plateau, as determined by the rate of earthquakes per area and the historical magnitude of these events, is relatively low when compared with other regions of the Pacific Northwest, the Puget Sound area, and western Montana/eastern Idaho (areas where several large earthquakes, Richter magnitude greater than 7, have occurred). Between 1870 and 1980, only five earthquakes occurred in the Columbia Plateau region that had MMI of VI or greater, and all these events occurred prior to 1937. The largest known earthquake in the Columbia Plateau (magnitude 5.75 and maximum MMI of VII) occurred in 1936 around Milton-Freewater, Oregon, approximately 100 km (62 mi) southeast of Hanford. In the central portion of the Columbia, the largest earthquakes near Hanford were two earthquakes that occurred in 1918 and 1973. Each was approximate magnitude 4.5 and MMI V, and located north of Hanford. Most of the earthquakes in the central Columbia Plateau occur north or northeast of the Columbia River as "earthquake swarms," which are clusters of low intensity earthquakes (MMI less than V) occurring over a short period of time (HF PNL 1994a:4.36).

Most known faults at Hanford are associated with anticlinal fold axes and include thrust, reverse, and normal faults. Faulting has occurred concurrently with folding. The age of latest displacement for the major features is less than 10.5 million years, but some steep dipping faults in the Rattlesnake Hills uplift may be as young as 7,000 years. Some faults in Central Gable Mountain (north-central Hanford) are capable faults as defined in 10 CFR 100, Appendix A.

Landslides are present in the region and have been generally attributed to earthquake activity. Recent findings, however, suggest these features are actually related to glacial flooding and periods of soil saturation with water. Only the slopes of the enclosing anticlinal ridges, including Gable Mountain and White Bluffs, are steep enough for landslide concern. White Bluffs east of the Columbia River poses the greatest concern because of the clay-rich nature of some beds above the river level, the discharge of large quantities of irrigation water into the ground atop the cliffs, the surface incline toward the Columbia River, and the eastward channel migration of the Columbia and its undercutting of the adjacent bluffs. Landslides could fill the Columbia River channel and divert water onto the reservation.

Several major volcanoes are located in the Cascade Range west of Hanford, including Mount Adams, located 164 km (102 mi) from Hanford, and Mount St. Helens, located approximately 218 km (134 mi) west-southwest from Hanford. As a result of the 1980 Mount St. Helens eruption, approximately 0.1 cm (0.04 in) of volcanic ash fell in a 9-hour period at Hanford.

Soils. Hanford is primarily underlain by soils of the Ritzville-Willis, Warden-Shano, Walla-Walla-Endicott-Lickskillet, and Hezel-Quincy-Burbank associations. These soils tend to vary in texture from sand to silty and sandy loam derived from five types of parent material: recent alluvium, old alluvium (glacial outwash), windblown sand, lacustrine deposits, and loess. The mineralogy of these soils results from weathering of local basalts, igneous and metamorphic rocks exposed to the north and east. The hazard of soil erosion varies from slight to severe. Water erosion becomes more severe with increasing slope; wind erosion becomes more severe on water-eroded slopes. The soils at Hanford are considered acceptable for standard construction techniques.

3.2.6 BIOLOGICAL RESOURCES

Terrestrial Resources. Vegetation at Hanford has been characterized as shrub-steppe. Present site development consists of clusters of large buildings that are found at widely spaced locations. Developed areas encompass about 6 percent of the site. The remaining areas of the site can be divided into 10 major plant communities (Figure 3.2.6–1). Hanford is dominated by communities in which big sagebrush is a major component. Other plant communities contain a variety of grasses and herbaceous plants. Areas previously disturbed by agricultural activities are dominated by nonnative species, such as cheatgrass. Trees are uncommon on the site, but those that are present include cottonwood and willow, which are both found near water bodies, and a few other deciduous species, which were originally planted near farmsteads as windbreaks. Nearly 600 species of plants have been identified at Hanford (DOE 1995o:4-85).

Hanford provides suitable habitat for numerous animal species, including 12 species of amphibians and reptiles, 187 species of birds, and 39 species of mammals (HF PNL 1994a:4.99,4.103). Common animal species at Hanford include the side-blotched lizard, gopher snake, western meadowlark, horned lark, Great Basin pocket mouse, and black-tailed jackrabbit. Trees planted around former farmsteads serve as nesting platforms for several species of birds, including hawks, owls, ravens, magpies, and great blue herons; these trees also serve as night roosts for bald eagles (HF PNL 1994a:4.92,4.93). The Hanford Reach of the Columbia River, including several sparsely vegetated islands, provides nesting habitat for the Canadian goose, ring-billed gull, Forster's tern, and great blue heron. Although several game animals are found at Hanford, only waterfowl hunting is permitted onsite north of the Columbia River (HF 1992a:1). Numerous raptors, such as the Swainson's hawk and red-tailed hawk, and carnivores, such as the coyote and bobcat, are found on Hanford. A variety of migratory birds has been found at Hanford. Migratory birds, as well as their nests and eggs, are protected by the *Migratory Bird Treaty Act*. Eagles are similarly protected by the *Bald and Golden Eagle Protection Act*.

Vegetative cover in the vicinity of the 200 Area, the proposed location of storage facilities, falls within the sagebrush and cheatgrass-Sandberg bluegrass community (Figure 3.2.6–1). Associated shrubs and grasses of this community include gray rabbitbrush, green rabbitbrush, hopsage, snowy buckwheat, Indian rice grass, thickspike wheatgrass, and needle-and-threadgrass. Common animal species found on the proposed site are expected to be similar to those described for Hanford as a whole.

Wetlands. Primary wetland areas at Hanford are found in the riparian zone along the Columbia River. The extent of this zone varies, but it includes large stands of willows, grasses, and other plants. This area has been extensively affected by hydropower operations at Priest Rapids Dam (DOE 1995o:4-89).

Other large areas of wetlands at Hanford can be found north of the Columbia River within the Saddle Mountain National Wildlife Refuge and the Wahluke Wildlife Unit Columbia Basin Area. These two areas encompass all the lands extending from the north bank of the Columbia River northward to the site boundary and east of the Columbia River down to Ringold Springs. Wetland habitat in these areas consists of fairly large ponds resulting from irrigation runoff. These ponds have extensive stands of cattails and other emergent aquatic vegetation surrounding the open water regions. They are extensively used as nesting sites by waterfowl (HF PNL 1994a:4.113).

On the western side of Hanford, Rattlesnake Springs supports a riparian zone of about 2.5 km (1.6 mi) in length, featuring watercress, bulrush, spike rush, cattail and peachleaf willow. Snively Springs also contains a diverse biotic community similar to Rattlesnake Springs (HF PNL 1994a:4.112).

Several semi-permanent artificial ponds and ditches that receive cooling water or irrigation wastewater are also present on Hanford near the 200 Area and support wetland vegetation (that is, cattails, reeds, and willows) around their periphery. These wetlands provide habitat for songbirds, shorebirds, and waterfowl.

Aquatic Resources. Aquatic resources on Hanford include the Columbia River, ephemeral streams, springs, surface ponds, and ditches. The Columbia River flows along the northern and eastern edges of Hanford (HF PNL 1994a:4.106).

The Hanford Reach supports 44 anadromous and resident species of fish. Many of the fish species present in the Hanford Reach are dependent upon flowing water and rocky substrate for at least part of their life cycles. Fall chinook salmon, steelhead trout, mountain whitefish, and smallmouth bass spawn in this area. The destruction of other mainstream Columbia River spawning areas by dams has increased the relative importance of the Hanford Reach for spawning (HF PNL 1994a:4.110).

The Hanford Reach provides a migration route to upstream spawning areas for spring, summer, and fall adult chinook salmon, coho salmon, sockeye salmon, and steelhead trout. It also provides rearing habitat for the salmonid juveniles in their downstream migration to the sea. Principal resident fish species sought by anglers in the Hanford Reach include mountain whitefish, white sturgeon, smallmouth bass, crappie, catfish, walleye, and perch (HF PNL 1994a:4.110,4.112).

The Yakima River borders the southern portion of Hanford. Game fish found in the river in the vicinity of the site are smallmouth bass, steelhead trout, and channel catfish. Cold Creek and its tributary, Dry Creek, are ephemeral streams within the Yakima River drainage system along the southern boundary of Hanford. These streams do not support any fish populations (HF 1992a:2; HF PNL 1994a:4.42).

There are several springs at Hanford. Rattlesnake Springs and Snively Springs, located in the western portion of the site, form short streams which seep into the ground (Figure 3.2.4–1). None of the springs support any fish populations (HF PNL 1984a:3.40; HF PNL 1994a:4.112).

The release of wastewater at Hanford facilities has created four semipermanent artificial ponds and several ditches that did not exist before these facilities were built. These are temporary and will disappear if the industrial release of water is terminated. All of the ponds, except West Pond and one ditch on the site, support goldfish. West Pond was created by a rise in the water table and is not fed by surface flow; thus, it is alkaline and has a reduced complement of biota (Figure 3.2.4–1) (HF PNL 1978a:2,3,5,10,13).

Threatened and Endangered Species. Sixty-five federally and State-listed threatened, endangered, and other special status species may be found in the vicinity of Hanford, 13 of these are federally or State-listed as threatened or endangered (Table 3.2.6–1). Forty-one species listed in Table 3.2.6–1 have been observed at Hanford or the Hanford Reach of the Columbia River, including nine of the federally or State-listed endangered or threatened species. Once specific project site locations have been determined, site surveys will verify the presence of special status species. No critical habitat, as defined in ESA (50 CFR 17.11 and 17.12), exists on Hanford.

The bald eagle is the only federally listed species known to be found at Hanford. It is a regular winter resident along the Hanford Reach, where it forages for salmon and waterfowl. Trees in the historic Hanford Townsite area are used by eagles for perching; however, eagles do not nest at Hanford. The peregrine falcon is a migrant in the Hanford area. The Aleutian Canada goose and Oregon silverspot butterfly are not known to occur on the site.

Several State-listed animal species have been observed at Hanford. The ferruginous hawk is known to nest on transmission towers and forages over much of the site. Habitats similar to those used by this species for foraging are relatively common at Hanford; however, nesting sites are more limited (DOE 1992e:4-26). Pygmy rabbits have only rarely been seen at Hanford. [Text deleted.] Species occurring along the Hanford Reach include the American white pelican and sandhill crane. The sandhill crane is also found in upland habitats (DOE 1992e:4-27; DOE 1995o:4-93).

State-listed plant species observed at Hanford include Columbia milk-vetch, Columbia yellowcress, and dwarf desert primrose. Columbia milk-vetch has been found onsite on top of Umtanum Ridge above the Midway substation. Columbia yellowcress occurs in the wetted zone of the water's edge along the Columbia River. It has been observed between the 100 B Area and the old Hanford Townsite. Dwarf desert primrose is known to grow in Ringold Flats and in a gravel pit approximately 2.5 km (1.6 mi) north of Wye Barricade (Figure 3.2.1–1) (HF WHC 1992a:3-1,3-5,3-6). Other State-listed plant species found in the vicinity of Hanford include northern wormwood and Hoover's desert parsley.

Table 3.2.6–1. Federally and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found on or in the Vicinity of Hanford Site

		Status[a]	
Common Name	**Scientific Name**	**Federal**	**State**
Mammals			
Fringed myotis	*Myotis thysanodes*	NL	M
Long-eared myotis	*Myotis evotis*	NL	M
Long-legged myotis	*Myotis volans*	NL	M
Merriam's shrew[b]	*Sorex merriami*	NL	C
Northern grasshopper mouse[b]	*Onychomys leucogaster*	NL	M
Pacific western big-eared bat[b]	*Plecotus townsendii townsendii*	NL	C
Pallid bat[b]	*Antrozous pallidus*	NL	M
Pygmy rabbit[b]	*Brachylagus idahoensis*	NL	E
Sagebrush vole[b]	*Lagurus curtatus*	NL	M
Small-footed myotis	*Myotis ciliolabrum*	NL	M
[Text deleted.]			
Birds			
Aleutian Canada goose[c]	*Branta canadensis leucopareia*	T	E
American white pelican[b,d]	*Pelecanus erythrorhynchos*	NL	E
Ash-throated flycatcher	*Myiarchus cinerascens*	NL	M
Bald eagle[b,c,d]	*Haliaeetus leucocephalus*	T	T
Black tern[b]	*Chlidonius niger*	NL	M
Black-crowned night heron	*Nycticorax nycticorax*	NL	M
Black-necked stilt	*Himantopus mexicanus*	NL	M
Common loon[d]	*Gavia immer*	NL	C
Ferruginous hawk[b]	*Buteo regalis*	NL	T
Flammulated owl[b]	*Otus fammeolus*	NL	C
Forester's tern	*Sterna forsteri*	NL	M
Golden eagle	*Aquila chrysaetos*	NL	C
Grasshopper sparrow	*Ammodramus savannarum*	NL	M
Gray flycatcher	*Empidonax wrightii*	NL	M
Great blue heron[b]	*Ardea herodias*	NL	M
[Text deleted.]			
Lewis' woodpecker[b]	*Melanerpes lewis*	NL	C
Loggerhead shrike[b]	*Lanius ludovicianus*	NL	C
Long-billed curlew	*Numenius americanus*	NL	M
Northern goshawk[b]	*Accipiter gentilis*	NL	C
Osprey	*Pandion haliaetus*	NL	M
Peregrine falcon[b,c]	*Falco peregrinus*	E (S/A)	E
Prairie falcon[b]	*Falco mexicanus*	NL	M
Sage sparrow[b]	*Amphispiza belli*	NL	C
Sage thrasher	*Oreoscoptes montanus*	NL	C
Sandhill crane[b,d]	*Grus canadensis*	NL	E

Table 3.2.6–1. Federally and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found on or in the Vicinity of Hanford Site—Continued

Common Name	Scientific Name	Status[a]	
		Federal	**State**
Birds (continued)			
Swainson's hawk[b]	*Buteo swainsoni*	NL	C
Turkey vulture	*Cathartes aura*	NL	M
Western bluebird[b]	*Sialia mexicana*	NL	C
Western burrowing owl[b]	*Athene cunicularia hypugea*	NL	C
Western grebe	*Aechmophorus occidentalis*	NL	M
Western sage grouse[b]	*Centrocerus urophasianus phaios*	NL	C
Reptiles			
Desert night snake[b]	*Hypsiglena torquata*	NL	M
Amphibians			
Woodhouse's toad[b]	*Buo woodhousei*	NL	M
Fish			
Mountain sucker[d]	*Catostomus platyrhnchus*	NL	M
Piute sculpin[d]	*Cottus beldingi*	NL	M
Reticulate sculpin[d]	*Cottus perplexus*	NL	M
Sandroller[d]	*Percopsis transmontana*	NL	M
Invertebrates			
Columbia River tiger beetle	*Cicindela columbica*	NL	C
Giant Columbia River limpet	*Fisherola nuttalli*	NL	C
Great Columbia River spire snail[d]	*Fluminicola columbianus*	NL	C
Oregon silverspot butterfly	*Speyeria zerene hippolyta*	T	E
Plants			
Bristly cyptantha	*Cryptantha interrupta*	NL	M2
Columbia milk-vetch[b]	*Astragalus columbianus*	NL	T
Columbia yellowcress[b]	*Rorippa columbiae*	NL	E
Dense sedge[b]	*Carex densa*	NL	S
Desert dodder	*Cuscuta denticulata*	NL	M1
Dwarf desert primrose[b]	*Oenothera pygmaea*	NL	T
False-pimpernel[b]	*Lindernia dubia var. anagallidea*	NL	S
Gray cryptantha[b]	*Cryptantha leucophaea*	NL	S
Hoover's desert parsley	*Lomatium tuberosum*	NL	T
Northern wormwood	*Artemisia campestris borealis var. wormskioldii*	NL	E
Piper's daisy[b]	*Erigeron piperianus*	NL	S
Shining flatsedge[b]	*Cyperus bipartitus*	NL	S
Southern mudwort[b]	*Limosella acaulis*	NL	S
Thompson's sandwort[b]	*Arenaria franklinii var thompsonii*	NL	M2

[a] Status codes: C=State candidate; E=endangered; M=monitored animal; M1=monitored plant - Group 1 (additional field work needed); M2=monitored plant - Group 2 (unresolved taxonomic question); NL=not listed; S=State sensitive; S/A=protected under the similarity of appearance provision of the *Endangered Species Act*; T=threatened.

[b] Species observed on Hanford Site.

[c] USFWS Recovery Plan exists for this species.

[d] Occurs along the Hanford Reach of the Columbia River.

Source: 50 CFR 17.11; 50 CFR 17.12; DOE 1992e; DOE 1995o; HF PNL 1994a; HF WHC 1992a; WA DNR 1994a; WA DOW 1994a.

Sagebrush habitat is considered priority habitat by the State of Washington because of its relative scarcity in the State and its use as a nesting and breeding habitat by loggerhead shrikes, burrowing owls, sage sparrows, pygmy rabbits, sage thrashers, western sage grouse, and sagebrush voles. Most of these species have been observed at Hanford.

The proposed storage site contains sagebrush habitat that is potentially suitable for use by the species listed above. The loggerhead shrike has been frequently observed in the vicinity and is known to select tall big sagebrush as nest sites. The 200 Area also contains a portion of the foraging range of nesting ferruginous hawks (DOE 1995o:4-93).

3.2.7 CULTURAL AND PALEONTOLOGICAL RESOURCES

Prehistoric Resources. Within the boundaries of Hanford, 248 prehistoric sites have been identified. A number of these sites have been identified along the Middle Columbia River and in inland areas away from the river but near other water sources. Some dispersed evidence of human occupation has been found in the arid lowlands. Sites include pithouse villages, campsites, cemeteries, spirit quest monuments (rock cairns), hunting camps and blinds, game drive complexes, quarries in mountains and rocky bluffs, hunting and kill sites in lowland stabilized dunes, and small, temporary camps near water located away from the river.

The NRHP lists 47 prehistoric resources at Hanford. Two of these are individual sites: the Hanford Island Site and the Paris Site. The remaining sites are divided into seven archaeological districts. Four sites, including Vernita Bridge, Tsulim, and two others, are considered eligible for the NRHP by the State Historic Preservation Officer (SHPO). In addition, a Determination of Eligibility nomination has been prepared for Gable Mountain/ Gable Butte, a traditional cultural property district (DOE 1995o:4-29).

All inventory and evaluation of cultural resources at Hanford is conducted within the framework of the *Hanford Cultural Resources Management Plan* (PNL-6942 UC-600, June 1989). Archaeological surveys have been conducted at Hanford since 1926, and slightly less than 10 percent of the area has been examined. These surveys have included studies of Gable Mountain, Gable Butte, Snively Canyon, Rattlesnake Mountain, Rattlesnake Springs, and a portion of the Basalt Waste Isolation Project Reference Repository Location. Most of the surveys have focused on islands and on a 400-m (1,312-ft) wide area on either side of the river. From 1991 through 1995, the 100 Areas were surveyed, and new sites were identified. Excavations have been conducted at several sites on the river banks and islands and at two unnamed sites. Test excavations have been conducted at the Wahluke, Vernita Bridge, and Tsulim sites, and at other sites in Benton County.

Facilities could be built or upgraded adjacent to or within the 200 or 400 Areas. An archaeological survey has been conducted in all undeveloped parts of the 200 East Area and half of the 200 West Area (HF PNL 1994a:4.127, 4.128). No prehistoric sites were identified. Because most of the 200 Areas are either developed or disturbed, it is unlikely that they contain intact archaeological deposits. Most of the 400 Area is disturbed and therefore is unlikely to contain intact prehistoric or historic sites. A cultural resources survey found 12 ha (30 acres) undisturbed in the 400 Area, and no sites were identified either within the 400 Area or within 2 km (1 mi) of the 400 Area. The *Hanford Cultural Resources Management Plan* provides for survey work before construction and has contingency guidelines for handling the discovery of previously unknown archaeological resources encountered during construction.

Historic Resources. There are 202 historic archaeological sites and other historic localities identified at Hanford. Pre-Hanford-era sites and localities include homesteads, ranches, trash scatters, dumps, gold mine tailings, roads, and townsites, including the Hanford townsite and the East White Bluffs townsite and ferry landing.

Lewis and Clark were the first European-Americans to come to this region, during their expedition of 1803 to 1806. Fur trappers soon followed. In the 1860s, settlement began in the area. Chinese miners came to work the gravel bars for gold. Farmers and cattlemen came to the area in the 1880s. The towns of Hanford, White Bluffs, and Ringold were established and grew. Two additional ferry operations, one at Wahluke and one at Richland, were established. The Hanford Engineering Works, a part of the Manhattan Project, was established in 1943. During that year, the residents were evacuated and nearly all the structures were subsequently razed. Pu produced at the Hanford 100 B-Reactor was used in the first nuclear explosion, at the White Sands Missile Range in New Mexico, and later in the bomb that was dropped on Nagasaki, Japan (DOE 1995o:4-32). The Hanford 100 B-Reactor is listed as a National Mechanical Engineering Landmark, a National Historical Civil Engineering Landmark, a National Nuclear Engineering Landmark, and is listed on the NRHP (HF PNL 1991a:6-3).

Because Hanford played an important role in the Manhattan Project and the subsequent Cold War Era, a number of its structures may be eligible for the NRHP. Although not all of these structures meet the Secretary of the Interior's 50-year requirement for eligibility, they fall under the broad themes of the Manhattan Project and Cold War Era nuclear production. They include buildings and structures found mainly in the 100, 200, and 300 Areas.

The historic White Bluffs Freight Road, once an Indian road, crosses diagonally through the 200 West Area. The road has been determined NRHP-eligible by the SHPO, but the segment in the 200 West Area is considered a noncontributing element. A 100-m (328-ft) easement protects the road. Manhattan Project and Cold War Era structures are in the 200 Areas; they have not been evaluated for NRHP eligibility.

Native American Resources. Because of its location on the Columbia and Yakima Rivers, Hanford has been home to Native Americans for thousands of years. The Wanapum and the Chamnapum band of the Yakama tribe lived along the Columbia River at what is now Hanford. Some of their descendants still live nearby at Priest Rapids, northwest of Hanford. Other groups that visited or lived intermittently at Hanford include the Palus, who lived on the lower Snake River, the Walla Walla, the Nez Perce, and the Umatilla (DOE 1995o:4-31). All these people retain secular and religious ties to the area. The Yakama, Umatilla, and Nez Perce have all been declared "Affected Indian Tribes," as defined in the NWPA of 1982. As such, these tribes and the Wanapum people, who live about 8 km (5 mi) west of the Hanford boundary, are active in decisions regarding the site. The tribes have expressed concerns regarding hunting, fishing, and pasture rights and access to plant and animal communities and important sites (HF DOE 1990e:2-20).

The Washane, or Seven Drums religion, originated among the Wanapum people on what is now Hanford and is still practiced by many people on the Yakama, Umatilla, Warm Springs, and Nez Perce Reservations. The first Washane ceremony took place at Coyote Rapids (HF DOE 1990e:3-60). Certain indigenous plants and animals found at Hanford are used in religious ceremonies. Sites sacred to Native Americans at Hanford include remains of prehistoric villages, cemeteries, ceremonial longhouses or lodges, rock art, fishing stations, and vision quest sites. Culturally important localities and geographic features include Rattlesnake Mountain, Gable Mountain, Gable Butte, Goose Egg Hill, Coyote Rapids, and the White Bluffs portion of the Columbia River.

Paleontological Resources. There are three geologic units at Hanford: the Columbia River Basalt group, the Ringold Formation, and the Hanford Formation. Pliocene and Pleistocene Age remains have been identified at Hanford. The Upper Ringold Formation dates to the Late Pliocene and contains fish, reptile, amphibian, and mammal fossil remains. Late Pleistocene Tuchet beds have yielded mammoth bones. These beds are composed of fluvial sediments deposited along ridge slopes that surround Hanford.

3.2.8 SOCIOECONOMICS

Socioeconomic characteristics described for Hanford include employment, regional economy, population, housing, community services, and local transportation. Statistics for employment and regional economy are presented for the REA that encompasses nine counties surrounding Hanford in Washington (Table L.1–1). Statistics for population, housing, community services, and local transportation are presented for the ROI, a three-county area in which 90.8 percent of all Hanford employees reside: Benton County (78.8 percent), Franklin County (8.9 percent), and Yakima County (3.1 percent) (Table L.1–2). In 1996, Hanford employed approximately 14,586 persons (approximately 4 percent of the total employment in the REA).

Regional Economy Characteristics. Selected employment and regional economy statistics for the Hanford REA are summarized in Figure 3.2.8–1. Between 1980 and 1990, the civilian labor force in the REA increased 10.3 percent to 254,777. The 1994 unemployment rate in the REA was 9.1 percent, significantly higher than the rate of 6.4 percent in Washington. In 1993, the REA per capita income of $18,501 was 15 percent lower than Washington's per capita income of $21,839.

Employment patterns in the REA parallel those in Washington, with manufacturing, retail trade, and services providing the majority of jobs. The service sector accounts for the highest percentage of employment in both the REA and Washington, 26.3 percent and 27.4 percent, respectively.

Population and Housing. Population and housing trends in the ROI are summarized in Figure 3.2.8–2. The ROI population, which totalled 379,693 in 1994, increased 19.8 percent during the period 1980 to 1994, much lower than the 29.3-percent increase in Washington. Population growth rates among the three counties composing the ROI, range from 18.1 percent in Benton County to 21.9 percent Franklin County.

Between 1980 and 1990, the number of housing units in the ROI increased by about 5 percent, compared to the 20-percent increase in Washington. However, homeowner and renter vacancy rates in 1990 were about the same in both the Hanford ROI and Washington, approximately 1 percent and 6 percent, respectively.

Community Services. Community services described for the Hanford ROI are education, public safety, and health care. Figure 3.2.8–3 presents school district characteristics for the Hanford ROI, and Figure 3.2.8–4 presents public safety and health care characteristics.

Education. Twenty-five school districts provide public education in the Hanford ROI. As shown in Figure 3.2.8–3, school districts were operating at capacities ranging from 63 percent to 125 percent in 1994. The student-to-teacher ratios in the ROI ranged from a low of 5.9:1 in the Kahlotus district to a high of 21.5:1 in the Kiona-Benton district. The average student-to-teacher ratio in the ROI was 18.9:1.

Public Safety. Fifteen city and county law enforcement agencies provide police protection in the ROI. In 1994 the highest sworn officer-to-population ratio in the ROI was 1.85 sworn officers per 1,000 persons in the city of Pasco. The ROI average officer-to-population ratio was 1.6 officers per 1,000 persons. Figure 3.2.8–4 displays the ratio of sworn police officers to population for the Hanford ROI counties and cities.

Thirty-seven fire departments provide fire protection services for the Hanford ROI. The principal municipal fire departments include both professional and volunteer staff. In 1995, the greatest staffing strength relative to population was in Franklin County, with 7.7 firefighters per 1,000 persons (Figure 3.2.8–4). The ROI average firefighter-to-population ratio was 4.0 firefighters per 1,000 persons.

Health Care. Eight hospitals serve the three-county region, with the majority operating well below capacity. In 1994, a total of 465 physicians served the ROI. Figure 3.2.8–4 shows that the average physician-to-population ratio in the ROI was 1.2 physicians per 1,000 persons, and the hospital bed-to-population ratio ranged from 2.0 beds per 1,000 persons in Benton County to 2.3 beds per 1,000 persons in Franklin and Yakima Counties.

Local Transportation. Interstate highways and State Routes provide access between Hanford and metropolitan areas (see Figure 2.2.1–1 and Figure 2.2.1–2). The east-west highways, Interstate 90 and Interstate 84, are located north and south of the site, respectively. Interstate 90 is the major link west to Seattle and east to Spokane. Interstate 84 is the major link to Portland, Oregon. Interstate 90 and Interstate 84 are connected by Interstate 82, which is located southwest of Hanford. Interstate 182 is located southeast of the site and provides an east-west corridor linking Interstate 82 to the Tri-Cities (Richland, Kennewick, and Pasco) area.

Vehicular access to Hanford is provided by several highways. State Route 240 is the preferred route from the Tri-Cities area. State Route 240 connects to the Richland bypass highway, which interconnects with Interstate 182. State Route 243 exits the site's northwestern boundary and serves as a primary link between the site and Interstate 90. State Route 24 enters the site from the west and continues eastward across the northernmost portion of the site and intersects State Route 26 approximately 16 km (10 mi) east of the site boundary. State Route 240 traverses the site in the southwestern section.

There are no current road improvement projects that affect access to Hanford. However, two projects currently in the planning stage could affect access to Hanford in the future. These projects are a realignment of State Route 240 from Stevens Drive to State Route 224 and an asphalt overlay of State Route 24 from Taylor Ranch to State Route 241 (WA DOT 1995a:1). The one road segment in the ROI that could be affected by the storage and disposition alternatives is State Route 240 from State Route 24 to State Route 224. In 1995, this road segment operated at level of service B.

The local intercity transit system, Ben Franklin Transit, supplies bus service between the Tri-Cities and Hanford. Both private interests and Ben Franklin Transit provide van pooling opportunities in the ROI.

Onsite rail transport is provided by a short-line railroad owned and operated by DOE. There is a total of 161 km (100 mi) of track. This line connects with the Union Pacific line just south of the Yakima River. The Union Pacific line interchanges with the Washington Central and Burlington Northern and Santa Fe at Kennewick. The rail system is mainly used to deliver coal to various boiler plants at Hanford. The rail system delivers equipment and material to the various facilities when rail shipment is more convenient than truck. There is no passenger rail service at Hanford.

In the ROI, the Columbia River is used as an inland waterway for barge transportation from the Pacific Ocean. The Port of Benton provides a barge slip where shipments arriving at Hanford may be off-loaded (HF County 1996a:1). [Text deleted.]

Tri-Cities Airport located near the city of Pasco provides jet air passenger and cargo service by both national and local carriers. Numerous smaller private airports are located throughout the ROI (DOT 1992a:7-325).

3.2.9 PUBLIC AND OCCUPATIONAL HEALTH AND SAFETY

Radiation Environment. Major sources and levels of background radiation exposure to individuals in the vicinity of Hanford are shown in Table 3.2.9–1. Annual background radiation doses to individuals are expected to remain constant over time. The total dose to the population changes as the population size changes. Background radiation doses are unrelated to Hanford operations.

Table 3.2.9–1. Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Hanford Site Operation

Source	Effective Dose Equivalent (mrem/yr)
Natural Background Radiation[a]	
Cosmic and cosmogenic radiation	30
External terrestrial radiation	30
Internal terrestrial radiation	40
Radon in homes (inhaled)	200
Other Background Radiation[b]	
Diagnostic x rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	365

[a] HF PNL 1994b.
[b] NCRP 1987a.
Note: Value for radon is an average for the United States.

Releases of radionuclides to the environment from Hanford operations provide another source of radiation exposure to individuals in the vicinity of Hanford. Types and quantities of radionuclides released from Hanford operations in 1993 are listed in the *Hanford Site Environmental Report for Calendar Year 1993* (PNL-9823). Doses to the public resulting from these releases are presented in Table 3.2.9–2. These doses fall within radiological limits (DOE Order 5400.5) and are small in comparison to background radiation. The releases listed in the 1993 report were used in the development of the reference environment's (No Action) radiological releases and resulting impacts for the year 2005 (Section 4.2.1.9).

Based on a risk estimator of 500 cancer deaths per 1 million person-rem to the public (Section M.2.1.2), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from Hanford operations in 1993 is approximately 1.6×10^{-8}. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of Hanford operations is less than 2 chances in 100 million. (Note that it takes several to many years from the time of radiation exposure for a cancer to manifest itself.)

Based on the same risk estimator, 1.8×10^{-4} excess fatal cancers are projected in the population living within 80 km (50 mi) of Hanford from normal operations in 1993. To place this number into perspective, it can be compared with the number of fatal cancers expected in this population from all causes. The 1990 mortality rate associated with cancer for the entire U.S. population was 0.2 percent per year (Almanac 1993a:839). Based upon this mortality rate, the number of fatal cancers expected during 1993 in the population living within 80 km (50 mi) of Hanford was 760. This number of expected fatal cancers is much higher than the estimated 1.8×10^{-4} fatal cancers that could result from Hanford operations in 1993.

Table 3.2.9–2. Radiation Doses to the Public From Normal Hanford Site Operation in 1993 (Committed Effective Dose Equivalent)

	Atmospheric Releases[a]		Liquid Releases		Total	
Members of the General Public	**Standard[b]**	**Actual**	**Standard[b]**	**Actual[c]**	**Standard[b]**	**Actual**
Maximally exposed individual (mrem)	10	0.020	4	0.012	100	0.032
Population within 80 km[d] (person-rem)	None	0.25	None	0.11	100	0.36
Average individual within 80 km[e] (mrem)	None	6.6×10^{-4}	None	2.9×10^{-4}	None	9.5×10^{-4}

[a] Includes direct radiation dose from surface deposits of radioactive material.

[b] The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10 mrem/yr limit from airborne emissions is required by the CAA, the 4 mrem/yr limit is required by the SDWA, and the total dose of 100 mrem/yr is the limit from all pathways combined. The 100 person-rem value for the population is given in proposed 10 CFR 834 (see 58 FR 16268). If the potential total dose exceeds the value, it is required that the contractor operating the facility notify DOE.

[c] The actual dose value given in the column under Liquid Releases conservatively includes all water pathways, not just the drinking water pathway.

[d] In 1993, this population was approximately 380,000.

[e] Obtained by dividing the population dose by the number of people living within 80 km of the site.

Source: HF PNL 1994b.

Hanford workers receive the same dose as the general public from background radiation, but they also receive an additional dose from working in the facilities. Table 3.2.9–3 presents the average worker, maximally exposed worker, and total cumulative worker dose to Hanford workers from operations in 1992. These doses fall within radiological regulatory limits (10 CFR 835). Based on a risk estimator of 400 fatal cancers per 1 million person-rem among workers (Section M.2.1.2), the number of fatal cancers to Hanford workers from normal operations in 1992 is projected to be 0.10.

Table 3.2.9–3. Radiation Doses to Workers From Normal Hanford Site Operation in 1992 (Committed Effective Dose Equivalent)

	Onsite Releases and Direct Radiation	
Occupational Personnel	**Standard[a]**	**Actual**
Average worker (mrem)	ALARA	27.3
Maximally exposed worker (mrem)	5,000	3,000
Total workers[b] (person-rem)	ALARA	258

[a] DOE's goal is to maintain radiological exposure as low as reasonably achievable.

[b] The number of badged workers in 1992 was approximately 9,470.

Source: 10 CFR 835; DOE 1993n:7.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the *Hanford Site Environmental Report for Calendar Year 1993* (PNL-9823). The concentrations of radioactivity in various environmental media (including air, water, and soil) in the site region (onsite and offsite) are also presented in that document.

Chemical Environment. The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (for example, surface water during swimming, soil through direct contact, or via the food pathway). The baseline data for assessing potential health impacts from the chemical environment are presented in Section 3.2.3.

Effective administrative and design controls that decrease hazardous chemical releases to the environment and help achieve compliance with permit requirements (for example, air emissions and NPDES permit requirements) contribute toward minimizing potential health impacts to the public. The effectiveness of these controls is verified through the use of monitoring information and through inspection of mitigation measures. Health impacts to the public may occur during normal operations at Hanford via inhalation of air containing hazardous chemicals released to the atmosphere by Hanford operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water or direct exposure, are low relative to the inhalation pathway.

Baseline air emission concentrations for hazardous chemicals and their applicable standards are included in the data presented in Section 3.2.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are in compliance with applicable guidelines and regulations. Information about estimating health impacts from hazardous chemicals is presented in Section M.3.

Exposure pathways to Hanford workers during normal operations may include inhaling the workplace atmosphere and direct contact with hazardous materials associated with work assignments. The potential for health impacts varies from facility to facility and from worker to worker, and available information is not sufficient to allow a meaningful estimation and summation of these impacts. However, workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. Hanford workers are also protected by adherence to Occupational Safety and Health Administration (OSHA) and EPA standards that limit workplace atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring, which reflects the frequency and amounts of chemicals utilized in the operational processes ensures that these standards are not exceeded. Additionally, DOE requirements ensure that conditions in the workplace are as free as possible from recognized hazards that cause, or are likely to cause, illness or physical harm. Therefore, worker health conditions at Hanford are expected to be substantially better than required by standards.

Health Effects Studies. Three epidemiological studies and a feasibility study have been conducted on communities around Hanford to determine if there are any excess cancers in the general population. One study found no excess cancers but identified an elevated rate of neural tube defects in progeny. This elevated rate was not attributed to parental employment at Hanford. A second study suggested that neural tube defects were associated with cumulative radiation exposure and also showed other defects that statistically were associated with employment at Hanford, but not with parental radiation exposure. The third study did not show any cancer risk associated with living near the facility.

Many epidemiologic studies have been carried out on the Hanford workers, including updated cohort analyses over the years. The studies have consistently shown a statistically significant elevated risk of death from multiple myeloma among Hanford male workers associated with radiation exposure. The excess was observed only among workers exposed to 10 radiation absorbed doses (rads) or more. Other studies have also identified an elevated risk of death from pancreatic cancers, but the elevated risk disappeared in a recent re-analysis of the updated cohort. Among Hanford female workers, studies have reported an elevated risk of deaths from musculoskeletal and connective tissue systems.

A more detailed description of the studies reviewed and the findings is found in Section M.4.2.

[Text deleted.]

Accident History. There have been 127 nuclear-process-related incidents with some degree of safety significance at Hanford over its period of operation. These do not include less-significant instances of radioactivity release or contamination during normal operations, which have been the subject of other reviews. The 127 incidents fall into 3 significant categories, based on the seriousness of the actual or potential consequences.

Fourteen of the incidents were Category 1, indicating that serious injury, radiation release or exposure above limits, substantial actual plant damage, or a significant challenge to safety resulted. Forty-six events were Category 2, less severe than Category 1, but involving significant cost or a less significant threat to safety. The remaining 67 incidents were Category 3, causing minor radiation exposure or monetary cost, or involving a violation of operating standards without a serious threat to safety (HF 1993a:1). [Text deleted.]

Emergency Preparedness. Each DOE site has established an emergency management program that would be activated in the event of an accident. This program has been developed and maintained to ensure adequate response for most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program incorporates activities associated with emergency planning, preparedness, and response.

Accordingly, DOE RL has developed and maintains a comprehensive set of emergency preparedness plans and procedures for Hanford to support onsite and offsite emergency management actions in the event of an accident. The DOE RL also provides technical assistance to other Federal agencies and to State and local governments. Hanford contractors are responsible for ensuring that emergency plans and procedures are prepared and maintained for all facilities, operations, and activities under their jurisdiction, and for directing implementation of those plans and procedures during emergency conditions. The DOE RL, contractor, and the State and local government plans are fully coordinated and integrated. Emergency control centers have been established by the DOE RL and its contractors for the principal work areas to provide oversight and support to emergency response actions within those areas.

3.2.10 WASTE MANAGEMENT

This section outlines the major environmental regulatory structure and ongoing waste management activities for Hanford. A more detailed discussion of the ongoing waste management operations is provided in Section E.2.1. Table 3.2.10–1 presents a summary of waste management activities at Hanford for 1993.

The Department is working with Federal and State regulatory authorities to address compliance and cleanup obligations rising from its past operations at Hanford. The DOE 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.

The EPA placed Hanford on the National Priorities List (NPL) on November 3, 1989. In accordance with the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA), DOE has entered into the Tri-Party Agreement with EPA and the State of Washington to govern the environmental compliance and cleanup of Hanford. Hanford has been divided into four aggregate waste sites (100, 200, 300, and 1100 Areas). An aggressive environmental restoration program is underway involving all areas of the site, using priorities established in the Tri-Party Agreement.

Hanford is the only DOE site with a preexisting agreement (Tri-Party Agreement) that meets the legal requirements specified under *Federal Facility Compliance Act.* Having this agreement exempts Hanford from having to develop a site treatment plan. This exemption is supported by written exemptions from the State of Washington and EPA. Both agencies determined that the *Report on Hanford Site Land Disposal Restrictions for Mixed Waste*, required by the Tri-Party Agreement, meets the intent of a site treatment plan. Hanford manages spent nuclear fuel and the following waste categories: high-level, TRU, low-level, mixed, hazardous, and nonhazardous. A discussion of the waste management operations associated with each of these categories follows.

Spent Nuclear Fuel. On April 29, 1992, DOE decided to discontinue reprocessing spent nuclear fuel solely to recover valuable materials. After the completion of several ongoing programmatic and site-specific reviews pursuant to NEPA, DOE will make decisions concerning the treatment and stabilization of the current Hanford inventory of spent nuclear fuel. Currently, spent N-Reactor, Shippingport Reactor, FFTF, and miscellaneous nuclear reactor fuel is stored in water-filled basins. Since spent nuclear fuel is not classified as waste, its management does not come under the regulations that apply to hazardous wastes, but instead is regulated by DOE Orders. Decisions concerning future receipt and management of spent nuclear fuel at Hanford will be made in accordance with the amended ROD published in the *Federal Register* on March 8, 1996 (61 FR 9441), for the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE/EIS-0203-F). The ROD specifies that spent nuclear fuel will be managed at Hanford, INEL, or SRS. Hanford production reactor fuel will remain at Hanford. As of 1995, Hanford has 2,133 t (2,351 tons), or 81 percent, of the total DOE existing spent fuel inventory. According to this ROD, a total of 12 shipments of non-Hanford produced reactor spent fuel will be sent from Hanford to INEL. Each shipment, either by truck or by rail, is assumed to consist of one shipping container. Hanford will not receive any additional fuel. As a result of this action, and assuming no final disposition, by the year 2035 Hanford will have 2,132 t (2,350 tons), or 78 percent, of the total existing DOE redistributed and newly generated inventory in the form of production reactor spent nuclear fuel (61 FR 9441).

A follow-on tiered, site-specific NEPA analysis for the management of the spent nuclear fuel from the K Basins was published in January 1996, *Final Environmental Impact Statement, Management of Spent Nuclear Fuel from the K Basins at the Hanford Site, Richland, Washington* (DOE/EIS-0245). Based on the analysis, an ROD was published in March 1996 (61 FR 10736). The decision consists of removing the spent nuclear fuel from the basins, vacuum drying, conditioning and sealing the spent nuclear fuel in inert-gas

Table 3.2.10–1. Spent Nuclear Fuel and Waste Management Activities at Hanford Site

Category	1993 Generation (m^3)	Treatment Method	Treatment Capacity (m^3/yr)	Storage Method	Storage Capacity (m^3)	Disposal Method	Disposal Capacity (m^3)
Spent Nuclear Fuel	None	Encapsulation	Planned	Reactor Basins. Non-Hanford production reactor spent fuel to be sent to INEL	2,133 t[a]	None—HLW Program in the future	NA
High-Level							
Liquid	None	Evaporation[b,c]	50,000[c]	Tank Farm	146,000[d]	NA	NA
Solid	None	NA	NA	NA	NA	None—HLW Program in the future	NA
Transuranic							
Liquid	None	See HLW	See HLW	Tank Farm	See HLW	NA	NA
Solid	271	None	NA	Containers on asphalt pads	15,370	None—WIPP or alternate facility in the future	None
Mixed Transuranic							
Liquid	0	See HLW	See HLW	Tank Farm	See HLW	NA	NA
Solid	98	None	NA	Containers on asphalt pads	15,370	None—WIPP or alternate facility in the future	None
Low-Level							
Liquid	None	Evaporation, separation, solidification	Evaporator in service, new vitrification facilities planned	None	NA	NA	NA
Solid	3,390	Compaction	4,000[e]	Not Stored	NA	Burial	902,900[f]
Mixed Low-Level							
Liquid	3,760	Evaporation, ion exchange[c]	50,000	Storage tanks, basins planned	446,500[g]	None	NA
Solid	1,505[h]	None	NA	RCRA facility, retrievable	1,218,700	Landfill, LLW Burial Grounds 218-E-NN	See solid LLW
Hazardous							
Liquid	See solid	None	NA	RCRA building	See solid	Commercial[i]	NA

Table 3.2.10–1. Spent Nuclear Fuel and Waste Management Activities at Hanford Site—Continued

Category	1993 Generation (m^3)	Treatment Method	Treatment Capacity (m^3/yr)	Storage Method	Storage Capacity (m^3)	Disposal Method	Disposal Capacity (m^3)
Solid	560[j]	None	NA	RCRA building	127	Commercial[i]	NA
Nonhazardous (Sanitary)							
Liquid	246,000 [k]	None	NA	None	NA	Septic tanks, french drains	Expandable
Solid	5,107	None	NA	None	NA	Richland Sanitary Landfill	Expandable
Nonhazardous (Other)							
Liquid	Included in sanitary	None	NA	None	NA	Percolation ponds, leachfields	Expandable
Solid	Included in sanitary	None	NA	None	NA	Landfill	Expandable

[a] Spent nuclear fuel is normally expressed in metric tons not cubic meters.

[b] Vitrification planned.

[c] 242-A Evaporator restarted in April 1994 after upgrades were completed. Assumes 242-A Evaporator as treatment method for liquid HLW and liquid TRU and mixed TRU.

[d] Consists of HLW and liquid TRU wastes in Double-Shell Tanks; Pu recovery and extraction aging waste. Includes 241-AN, 241-AP, 241-AW, 241-AY, 241-AZ, and 241-SY Tank Farms.

[e] Compaction by LLW Compactor (213-W).

[f] Includes the LLW Burial Grounds (unit 218-E-NN) and Low-Level Mixed Waste Disposal Facility (Project W-025).

[g] Assumes storage of liquid mixed LLW in tanks and planned basins.

[h] Consists of 1,500 m^3 of RCRA-regulated mixed LLW and 8.2 t of *Toxic Substances Control Act*-regulated mixed LLW. Volume estimate for TSCA-regulated mixed LLW was made based on a density factor of 1,500 kg/m^3.

[i] Offsite at RCRA facility.

[j] Consists of 628 t (RCRA-regulated), 72.8 t (State-regulated), and 139 t (TSCA-regulated). A volume estimate was made based on a density factor of 1,500 kg/m^3 for solids.

[k] No data. Estimate made based on employment of 14,856 and 30 gal/person/day for 250 days.

Note: NA=not applicable.

Source: 61 FR 9441; DOE 1993h; DOE 1994d; DOE 1994k; HF DOE 1993a; HF MMES 1993a; HF WHC 1995c; ORNL 1993a.

filled canisters for dry vault storage in a new facility, to be built at Hanford, for up to 40 years pending decisions on ultimate disposition.

High-Level Waste. High-level waste was generated in the recovery of uranium and Pu from spent fuel generated in the production reactors. All of this radioactive waste is considered mixed waste because of its toxic and hazardous constituents as defined by RCRA. It must be remotely handled because of its high radiation levels. The waste was generated as liquids and sludges and stored in underground tanks where the sludges and salts in the liquid have precipitated out of solution as porous solids (called salt cake) and settled to the bottom of the tanks. The liquid above the solids has been pumped from the older, single-shelled tanks into newer, double-shelled tanks. The liquids that remain in the porous salt cake will be removed by boring holes through the salt cake and extracting liquids from near the tank bottoms. The wastes are segregated and handled according to their hazardous nature (corrosivity, chemical stability, heat generation rates), and require special monitoring and venting. Cooling is needed for some of these wastes. The wastes are concentrated by evaporation and returned to the tanks for storage until final processing to a form suitable for disposal in a Federal repository. It is planned to vitrify HLW water-soluble sludges and selected radionuclides separated from liquids retrieved from the tanks. Vitrification of all waste from tanks is expected to be completed by 2028. In addition to this liquid and solid HLW, an inventory of encapsulated Cs and Sr is stored in the Waste Encapsulation and Storage Facility in a water-cooled pool. Some of this material was used as irradiation sources in, for example, radiography and food irradiation. [Text deleted.]

Transuranic Waste. Before 1970, TRU waste was buried in near-surface trenches. These wastes will require retrieval, segregation, processing, certification, and packaging before their final disposal. At the same time, the burial sites themselves will require extensive remediation. TRU wastes generated since 1970 have been separately stored in near-surface trenches (both lined and unlined) or in aboveground buildings. These wastes will also require assay, recertification, and possibly repackaging. Some TRU wastes generated since 1986 have been packaged and certified to the WIPP WAC. The best available treatment technologies will be utilized, as required, on a case-by-case basis, to process the retrieved wastes before repackaging and certification for WIPP. Storage facility expansion for these wastes at the Hanford Site Central Waste Complex is anticipated as remedial operations continue. Treatment of contact-handled TRU wastes will be provided in the future at the Waste Retrieval and Processing Facility. The waste in the underground storage tanks described in the previous HLW section contains some Pu. The final disposition of this waste awaits the development of technology and agreements with stakeholders and regulatory bodies. All currently generated contact-handled TRU waste is being placed in above-grade storage buildings at the Hanford Site Central Waste Complex and the TRU Storage and Assay Facility. TRU wastes will be maintained in storage until a suitable disposal facility is qualified for TRU waste disposal. Hanford would develop the appropriate treatment capabilities to meet the criteria of the designated repository. Mixed TRU waste quantities are included in the TRU waste category, since all these wastes are destined for ultimate disposal in WIPP depending on decisions made in the ROD associated with the supplemental EIS being prepared for the proposed continued phased development of WIPP for disposal of TRU waste.

Low-Level Waste. Low-level waste is generated when separated from HLW, TRU waste, and mixed wastes in the processing of tank wastes, and also from remediation activities. Solid LLW is accumulated at the originating sites, compacted, and shipped to the Low-Level Burial Ground in the Hanford Central Waste Complex located in the 200 West Area. Additional LLW is received from offsite generators and disposed of in a series of unlined near-surface trenches. The LLW resulting from the tank waste remediation system waste preteatment program will be vitrified by the end of 2028; as a near-term contingency, the Grout Facility will be maintained in a standby condition. The vitrifed LLW will be disposed of onsite in the 200 Area at Hanford by the tank waste remediation system program.

Mixed Low-Level Waste. Ninety-nine percent of the mixed waste at Hanford is contained in tank farms. The only treatment facility currently in place for these wastes is the 242-A Evaporator, which operates to reduce the volume of these wastes. Solid waste is segregated by its hazardous characteristics (ignitability, corrosivity, reactivity, and toxicity) and stored in buildings in the mixed waste storage facility. Defueled submarine reactor compartments continue to be received and disposed of in earthen trenches. These compartments have contained polychlorinated biphenyls (PCBs), but the Navy has a program to remove PCBs before the compartment disposal. Previously disposed mixed waste will be evaluated, treated, and disposed of according to designated criteria. Facilities completed or under construction to treat mixed wastes at Hanford are the Effluent Retention Facility, Effluent Treatment Facility (ETF) (filtration, oxidation, and ion exchange), 200 and 300 Area Treated Effluent Disposal Facility, LLW Vitrification Facility (stabilization), and the Waste Receiving and Processing Facility. Some of these facilities are scheduled to begin operations before the year 2000 to meet legally obligated milestones established in the Tri-Party Agreement and in consent orders.

Hazardous Waste. Hazardous waste is generated by various activities at PNL and from remediation and maintenance processes onsite. Except for the Interim Hazardous Waste Treatment Facility, which performs distillation, neutralization, and solidification, there are no treatment facilities for hazardous waste at Hanford; therefore, these wastes are accumulated in satellite storage areas (for less than 90 days) or at interim RCRA-permitted facilities, such as the Nonradioactive Dangerous Waste Storage Facility (Building 616), and at PNL (Building 305-B). The waste is shipped offsite by truck using DOT-approved transporters for treatment and disposal at RCRA-permitted facilities. A facility is being planned at PNL to dispose of the small volume of PNL hazardous waste and to be used for treatment technology development and demonstration.

Nonhazardous Waste. Wastewater from the process areas is treated in the 200 West Area Treatment Facility and then discharged to percolation ponds. In the future, these waste streams will be processed in an integrated liquid effluent system using a combination of local and central treatment systems. Sanitary wastewater is discharged to individual septic tanks and subsurface disposal systems. No data are collected on these waste streams. New systems will be added as processes move to different areas of the site. Sanitary wastes are estimated from standard engineering data for Hanford. Nonhazardous solid wastes are disposed of in the 600 Area central landfill. In October 1995, it was announced that DOE and the city of Richland reached an agreement to send the site's nonregulated and nonradioactive solid wastes to the Richland Sanitary Landfill. Coal waste is disposed of in landfills near the 200 East and 200 West Area powerhouses.

3.3 NEVADA TEST SITE

The Nevada Test Site is located in the southeastern part of Nye County in southern Nevada. The location of NTS within the State of Nevada is illustrated in Figure 2.2.2–1. NTS is operated by a management and integration contractor under the direction of the Nevada Operations Office. It is a remote, secure facility for conducting underground testing of nuclear weapons and evaluating the effects of nuclear weapons on military communications systems, electronics, satellites, sensors, and other materials. The first nuclear test at NTS was conducted in January 1951. Since the signing of the *Threshold Test Ban Treaty* in 1974, it has been the only U.S. site used for nuclear weapons testing.

Approximately one-half of the land (located in the eastern and northwestern portions of the site) is used for nuclear weapons testing, one-quarter (located in the western portion of the site) is reserved for future missions, and one-quarter is used for research and development and other facility requirements. Facilities include nuclear device assembly, diagnostic canister assembly, hazardous liquid spill, and the Radioactive Waste Management Site (RWMS). Figure 2.2.2–2 indicates the location of existing facilities within NTS.

In addition, Yucca Mountain, an area located on the western boundary of the site, is being characterized as directed by the NWPA of 1982, as amended, to determine its suitability as a repository for the disposal of commercial and DOE-owned spent nuclear fuel and radioactive HLW. DOE published an NOI for the preparation of an EIS (August 7, 1995) to evaluate a proposed action to construct, operate, and eventually close a geological repository.

Activities at NTS are concentrated in several general areas. Most of the onsite work is related to defense program activities, although environmental management, other DOE, and non-DOE activities are conducted as well. NTS is a unique facility because it is a large, open area into which access is tightly controlled; it has a substantial infrastructure; and it has the capability to handle and run tests using hazardous or radioactive materials. Because of this, activities other than nuclear testing, including mobile missile transporter tests and nuclear rocket tests, have been carried out for other Federal departments and agencies.

Department of Energy Activities. The NTS was established as the site within the United States where underground testing of nuclear weapons would occur. Since that time, other missions have been added due to the nature of the site. Likewise some activities have been terminated or not actively pursued. The current missions at NTS are shown in Table 3.3–1.

Table 3.3–1. Current Missions at Nevada Test Site

Mission	Description	Sponsor
Defense	Stockpile stewardship, including the maintenance of readiness to conduct an underground nuclear test, if directed	Assistant Secretary for Defense Programs
Waste management	Safe and permanent disposal of waste through either disposal on the NTS or to offsite commercial waste treatment or disposal facilities	Assistant Secretary for Environmental Management
Environmental restoration	Identify contaminated areas and cleanup those areas, as appropriate	Assistant Secretary for Environmental Management
Nondefense research & development	Original research efforts by the DOE, universities, industry, and other federal agencies	Various Federal Departments and Agencies
Work for others	Use of NTS areas and facilities by other groups and agencies for activities such as military training exercises	Various Federal Departments and Agencies

Source: DOE 1995i.

In addition to DOE nuclear testing activities at NTS, the Defense Special Weapons Agency has conducted tests that provide DoD with data regarding vulnerability and survivability of nuclear and nonnuclear weapons systems produced by the United States. DOE defense activities at NTS are closely related to Defense Special Weapons Agency activities, with both contributing to national security. The moratorium on U.S. nuclear testing began in October 1992 in accordance with the Hatfield Amendment. At the same time, however, the President required that NTS retain the capability to resume testing if authorized. Before the moratorium, nuclear testing was limited to those tests that supported the safety and reliability of the Nation's nuclear stockpile. [Text deleted.] In July 1993, the President extended the moratorium on nuclear tests (both DOE and DoD) indefinitely, but continued to require testing capabilities at NTS.

A facility for DOE activities, the 9,300 m^2 (100,000 ft^2) DAF, is located south of Control Point One in Area 6. Both LANL and LLNL can use this facility for conducting multiple operations with high explosives and nuclear devices simultaneously. Because of its multiple facilities areas that include assembly cells, assembly bays, high bays, radiographic facilities, special nuclear materials laboratories, high explosive (HE) storage, special nuclear material storage, shipping and receiving areas, and associated administrative and support areas, all aspects of nuclear device preparations could be handled in this one facility. In addition, the facility could provide increased overall security and allow easier entrance and exit accessibility for the workers during hazardous operations. There would be no manufacturing of special nuclear material at this facility.

There are active radioactive and mixed waste disposal areas onsite in Areas 3 and 5. The only major environmental management facility anticipated for NTS is a waste management facility to handle TRU wastes. A major program to characterize the groundwater at NTS is in progress to determine regional flow paths and rates and to detect any migration of contamination from past nuclear testing.

Although the principal activity at NTS has been the underground testing of nuclear devices, DOE is also involved in a number of other activities, including:

- The Yucca Mountain site in southern Nevada is being evaluated for its suitability as a repository to dispose of commercial and DOE-owned spent nuclear fuel and HLW. The Yucca Mountain Site Characterization Office (YMSCO) is conducting the site characterization activities and reports directly to Office of Civilian Radioactive Waste Management. However, because Yucca Mountain is collocated with NTS, the DOE Nevada Operations Office provides some administrative support services to YMSCO.

- The Spill Test Facility in Area 5 was completed in 1986. It is operated on a fee basis for commercial users as a basic research tool to study the dynamics of accidental releases of hazardous materials and to evaluate the effectiveness of various foams and fire retardants in accidents involving chemicals and hazardous materials.

Non-Department of Energy Activities. The main non-DOE activity at NTS was the Defense Special Weapons Agency's use of the site as a nuclear weapons effects testing facility in Area 12. Weapons effects tests were conducted to study a number of nuclear effects, including x-rays, gamma rays, neutrons, electromagnetic pulse, air blast, ground and water shock, propagation, and temperature. These tests assessed military systems in a nuclear environment. These tests were carried out in underground tunnels, including the P-Tunnel which is being considered for long-term storage alternatives in this PEIS. Various other military exercises and training activities are currently carried out at NTS.

3.3.1 LAND RESOURCES

Land Use. The NTS occupies approximately 350,000 ha (approximately 864,000 acres) (NT DOE 1996c:4-1; NT DOE 1994d:2) in southern Nye County of southern Nevada, with the southwestern boundary located approximately 16 km (10 mi) from California. The town of Indian Springs and Indian Springs Air Force Auxiliary Field in northeast Clark County, Nevada, are located 39 km (24.2 mi) southeast of the NTS boundary. All of the land within NTS is owned by the Federal Government and is administered, managed, and controlled by DOE. NTS is entirely bordered by Federal land—to the north, east, and west by Nellis Air Force Range, and to the south by land administered by the BLM.

In the mid-1800s, lands that now comprise NTS were included within the boundary of the Ruby Valley Treaty between the United States and the Western Bands of the Shoshone Indians. In 1951, the Shoshone tribe sought compensation for the loss of aboriginal title to these lands and was later awarded $26 million (NT DOE 1995e:2). The land area that today constitutes the current NTS configuration was withdrawn from all forms of appropriation under the public land laws, including mining and mineral-leasing laws through four Public Land Orders and a Memorandum of Understanding with the U.S. Air Force (NT DOE 1996c:4-5, 4-8, 4-9). The NTS boundary is defined by the four land withdrawals (NT DOE 1996f:2). On February 12, 1952, Public Land Order 805 reserved approximately 176,040 ha (435,00 acres) of land for use by the Atomic Energy Commission (AEC) as a weapons testing site. Approximately 15,540 ha (38,400 acres) were reserved for the use of the AEC in connection with NTS under Public Land Order 1662 on June 20, 1958. The lands described under this Public Land Order are not considered for any storage and disposition alternative and therefore are not addressed in this PEIS (NT DOE 1996c:4-5).

On December 19, 1961, approximately 128,691 ha (318,000 acres) of land previously reserved for use by the U.S. Air Force were transferred to the jurisdiction of the AEC for use in connection with NTS for test facilities, roads, utilities, and safety distances under Public Land Order 2568. Approximately 8,542 ha (21,108 acres) of land were reserved for the jurisdiction of the AEC for use in connection with NTS on August 3, 1965 under Public Land Order 3759. The northern portions of Areas 19 and 20, which encompass approximately 42,994 ha (106,240 acres), is managed by DOE as part of NTS in accordance with a 1963 Memorandum of Understanding with the U.S. Air Force. This memorandum was superseded by a Memorandum of Understanding between the U.S. Air Force and DOE/NV in 1982 (NT DOE 1996c:4-5). Therefore, the NTS site boundary does not include Pahute Mesa (NT DOE 1996f:2).

Existing Land Use. Generalized land uses at NTS and its vicinity are shown in Figure 3.3.1–1. NTS is divided into three major regions (Figure 3.3.1–2). The northern and eastern regions of NTS constitute the underground nuclear weapons test area. Nuclear test ranges are located at Yucca Flat, Pahute Mesa, Rainier Mesa, and Buckboard Mesa. The southwestern region of NTS (Area 25) provides support for nonweapons and nonnuclear weapons programs, such as the site characterization studies at Yucca Mountain, and for short-term activities, such as the Nuclear Weapons Accident Exercises conducted by the Nuclear Emergency Search Team. The remaining region contains the nonnuclear explosives test area and primary administrative and support area of NTS. NTS is subdivided into numbered areas, many of which are used or reserved for specific purposes.

In 1992, DOE designated all of NTS as a NERP. The NERP is used by the national scientific community as an outdoor laboratory for research on the effects of human activities on the desert ecosystem (DOE 1994u:v,31). There is no prime farmland present within NTS. Past agricultural activities were limited to an EPA agricultural and animal radiological research facility that closed in 1981. Offsite agricultural activity occurs on the south side of U.S. Route 95 and is limited to a cattle allotment granted by the BLM.

The Timber Mountain Caldera National Natural Landmark is located in the northwest portion of NTS. It is separated from much of NTS by mountains along its eastern border. A recommendation to include approximately 539,000 ha (1,333,000 acres) of the Desert National Wildlife Range (DNWR), which is managed by the USFWS, in the National Wilderness Preservation System has been tabled (NV FWS 1994a:3-5,3-6). This area of the DNWR is also part of the Nellis Air Force Range; it is jointly managed by the U.S. Air Force and USFWS. Public entry to this part of the wildlife range is generally prohibited by the Air Force, however, public entry that is allowed onto the DNWR does not occur in areas with views of NTS (NTS 1995a:6). The closest residence is located 2 km (1.3 mi) south of the NTS boundary, in the unincorporated town of Amargosa Valley.

Land-Use Planning. The Department has prepared a sitewide EIS for NTS that analyzes the environmental impacts associated with managing NTS and its resources. Four alternatives, including No Action, are presented in the EIS, with land-use and zoning categories described for each alternative. Land-use planning does not occur at the State level in Nevada; however, counties and other municipalities may plan if they so choose. The recently adopted Nye County comprehensive plan is a policy document that permits Nye County to begin a process of establishing a comprehensive land-use plan and zoning ordinance. No municipalities within Nye County have adopted land-use plans, policies, or controls (NT County 1995a:1).

Visual Resources. The NTS is located in a transition area between the Mojave Desert and the Great Basin. Vegetation characteristic of both deserts are found on NTS. The topography of NTS consists of a series of north-south oriented mountain ranges separated by broad, low-lying valleys and flats. Site topography is also characterized by the presence of numerous subsidence craters resulting from past nuclear testing. The southwestern Nevada volcanic field, which includes portions of NTS, is a nested, multicaldera volcanic field. The facilities of NTS are widely distributed across this desert setting.

The area surrounding NTS is unpopulated to sparsely populated desert and rural lands. Access to areas that would have views of NTS is controlled by NTS or the U.S. Air Force; therefore, there are few viewpoints accessible to the general public. Public viewpoints of NTS along U.S. Route 95, the principal highway between Tonopah and Las Vegas, are limited to Mercury Valley due to the various mountain ranges surrounding the NTS southern boundary. The primary viewpoint in the Mercury Valley is a roadside turnoff containing Nevada Historical Marker No. 165 of the Nevada State Park System, entitled "Nevada Test Site." The NTS facilities within 8 km (5 mi) are visible from this viewpoint. The main base camp at Mercury, located in Area 23, is well defined at night by facility lighting. The developed areas of NTS are consistent with a BLM VRM Class 5 designation. Other areas range from Class 2 to Class 4.

3.3.2 SITE INFRASTRUCTURE

Baseline Characteristics. Activities at NTS are concentrated at facilities in several general areas. Section 3.3 describes current NTS missions. To support these missions, an extensive infrastructure exists, as shown in Table 3.3.2–1.

Table 3.3.2–1. Nevada Test Site Baseline Characteristics

Characteristics	Current Usage	Site Availability
Transportation		
Roads (km)	640	1,100[a]
Railroads (km)	0	0
Electrical		
Energy consumption (MWh/yr)	121,460	176,844
Peak load (MWe)	27	45
Fuel		
Natural gas (m^3/yr)	0	0
Oil (l/yr)	5,716,000	5,716,000
Coal (t/yr)	0	0
Steam (kg/hr)	0	0

[a] Includes paved and unpaved roads.
Source: NTS 1993a:4.

The onsite transportation capability at NTS provides for safe and secure movement of nuclear materials. Movements are made via truck to and around the site. Improved and unimproved roads cover most of the NTS. Railbeds have existed in both Areas 25 and 26 for experimental purposes. These railbeds are neither maintained nor connected. Currently, there is no operating rail on NTS.

The regional electric power pool in which NTS is located, and from which it draws power, is the California-Southern Nevada Power Area. Electricity is provided by two independent 138-kilovolt (kV) lines. The capacity of the system is approximately 45 MWe. The site is near a major electrical hub that ties into several other areas.

Coal, nuclear, hydroelectric and geothermal, and oil and gas all contribute significantly to the region's electrical power system. Generating capacity margin for the regional pool is at 21 percent of current peak demand (see Table 3.3.2–2).

The NTS water supply system consists of 13 supply wells, pumps, booster pumps, and many sumps, reservoirs, chlorinator water softeners, and 160 km (100 mi) of supply lines. This water system is capable of producing 284 million l/week (75 million gal/week).

A major facility that could be used to store materials within the scope of this PEIS is the P-Tunnel complex located in Area 12 in the northern portion of NTS. This facility is a 1,000 m (3,281 ft) tunnel with multiple side drifts and an average earth cover of approximately 260 m (853 ft). The tunnel and drifts vary in dimension, but most are larger than 4 m (13 ft) in diameter and are lined with shotcrete. The Defense Special Weapons Agency used the P-Tunnel to perform underground nuclear effects tests.

Table 3.3.2–2. California–Southern Nevada Sub-Regional Power Pool Electrical Summary

Characteristics	Energy Production
Type Fuel	
Coal	14%
Nuclear	15%
Hydro/geothermal	19%
Oil/gas	22%
Other[a]	30%
Total Annual Production	246,012,000 MWh
Total Annual Load	293,262,000 MWh
Energy Imported Annually[b]	45,400,000 MWh
Generating Capacity	61,681 MWe
Peak Demand	57,028 MWe
Capacity Margin[c]	11,809 MWe

[a] Includes power from both utility and nonutility sources.

[b] Energy imported is not the difference of production and load due to positive net pumped storage.

[c] Capacity margin is the amount of generating capacity available to provide for scheduled maintenance, emergency outages, system operating requirements, and unforeseen electrical demand.

Source: NERC 1993a.

3.3.3 AIR QUALITY AND NOISE

Meteorology and Climatology. The climate at NTS and in the surrounding region is characterized by limited precipitation, low humidity, and large diurnal temperature ranges. The lower elevations are characterized by hot summers and mild winters, which are typical of other Great Basin desert areas. As elevation increases, precipitation increases and temperatures decrease (NT DOE 1986b:3-46).

The average annual temperature at NTS is 19.5 °C (67.1 °F); temperatures range from an average daily minimum of 0.9 °C (33.6 °F) in January to an average daily maximum of 41.1 °C (105.9 °F) in July. The average annual precipitation at NTS is 10.5 cm (4.13 in). Prevailing winds at NTS vary by location. The average annual windspeed is 4.2 m/s (9.4 mph) (NOAA 1994d:3). Additional information related to meteorology and climatology at NTS is presented in Appendix F.

Ambient Air Quality. The NTS is located within the Nevada AQCR (#147). The region is designated as an attainment area (40 CFR 81.329) with respect to NAAQS for criteria pollutants. Applicable NAAQS and Nevada State ambient air quality standards are presented in Appendix F.

Two PSD (40 CFR 52.21) Class I areas in the vicinity of NTS are Grand Canyon National Park, approximately 193 km (120 mi) southeast of the site, and Sequoia National Park, California, approximately 169 km (105 mi) west-southwest of the site. Since the creation of the PSD program in 1977, no PSD permits have been required for any emissions source at NTS.

The primary emission sources of criteria air pollutants at NTS include particulates from construction and other surface disturbances, fugitive dust from unpaved roads, various pollutants from fuel-burning equipment, incineration, open burning, and volatile organic chemicals (VOCs) from fuel storage facilities. A summary of emission estimates for sources at NTS is presented in Appendix F.

Table 3.3.3–1 shows the site baseline ambient air concentrations for criteria pollutants and other pollutants of concern at NTS. No hazardous air pollutants or other toxic compound sources are indicated. Baseline concentrations are in compliance with applicable guidelines and regulations. Elevated levels of O_3 and PM_{10} may occur occasionally because of pollutants transported into the area by wind or because of local sources of fugitive particulates. Concentrations of other criteria pollutants are low because there are no large emission sources nearby. The nearest nonattainment area is the Las Vegas area (40 CFR 81.329), located approximately 105 km (65 mi) southeast of NTS.

Noise. Major noise emission sources within NTS include various industrial facilities, equipment and machines (for example, cooling systems, transformers, engines, pumps, boilers, steam vents, paging systems, construction and materials handling equipment, and vehicles), and aircraft operations. No known noise surveys have been conducted at NTS to determine background sound levels. Most industrial facilities at NTS are at sufficient distance from the site boundary that noise levels at the boundary from these sources would not be measurable or would be barely distinguishable from background noise levels.

The acoustic environment around NTS is primarily uninhabited desert and small rural communities. In the uninhabited desert, the major sources of noise are natural physical phenomena, such as wind, rain, and wildlife activities, and an occasional airplane. The wind is the predominant noise source. Desert noise levels as a function of wind have been measured at an upper limit of 22 dBA for a still desert and 38 dBA for a windy desert (Webb 1983a:170). A background sound level of 30 dBA is probably a reasonable estimate. This agrees with other estimates of sound levels for rural areas. Annual rural-community day and night average sound levels (DNL) have been estimated in the range of 35 to 50 dBA and are considered to be a reasonable estimate for Indian Springs, Mercury, and the town of Amargosa Valley (EPA 1974a:B-4). Except for the prohibition of nuisance noise, neither the State of Nevada nor its local governments have established specific numerical environmental noise standards applicable to NTS.

Table 3.3.3–1. Comparison of Baseline Ambient Air Concentrations With Most Stringent Applicable Regulations or Guidelines at Nevada Test Site, 1990-1992

Pollutant	Averaging Time	Most Stringent Regulation or Guideline[a] ($\mu g/m^3$)	Baseline Concentration[b] ($\mu g/m^3$)
Criteria Pollutants			
Carbon monoxide	8-hour	10,000[c]	2,290
	1-hour	40,000[c]	2,748
Lead	Calendar Quarter	1.5[c]	[d]
Nitrogen dioxide	Annual	100[c]	[d]
Ozone	1-hour	235[c]	[e]
Particulate matter less than or equal to 10 microns in diameter	Annual	50[c]	9.4
	24-hour	150[c]	106
Sulfur dioxide	Annual	80[c]	8.4
	24-hour	365[c]	94.6
	3-hour	1,300[c]	725
Mandated by the State of Nevada			
Hydrogen sulfide	1-hour	112[f]	[d]

[a] The more stringent of the Federal and State standards is presented if both exist for the averaging time.

[b] Modeled concentration based on permit data except for CO which are monitored values.

[c] Federal and State standard.

[d] No sources of this pollutant have been identified.

[e] Ozone, as a criteria pollutant, is not directly emitted or monitored by the site. See Section 4.1.3 for a discussion of ozone-related issues.

[f] State standard.

Source: 40 CFR 50; NT REECO 1990a; NV DCNR 1992a; NV DCNR 1995a.

3.3.4 WATER RESOURCES

Surface Water. There are no continuously flowing streams on NTS. The most noticeable natural hydrologic features of NTS are the playas (lake beds) that collect stormwater runoff. Runoff in the eastern half of the site ultimately collects in the playas of Yucca Flat and Frenchman Flat. In the northeastern portion, runoff drains outside the test site and onto the Nellis Air Force Range Complex. In the western half and southernmost portion, runoff is carried offsite towards the Amargosa Desert. Figure 3.3.4–1 shows the location of the playas and flats. A few natural springs can be found at NTS. Surface water is not used at NTS.

There have been no studies conducted to assess 500-year floodplain boundaries at NTS. Two 100-year flood analyses have been conducted; these analyses show no runoff from a 100-year storm affecting the proposed project areas. One analysis was for Jackass Flats, but it is not near the proposed project areas. The 100-year floodplain study has been completed for the radioactive waste management site located in Area 5. This showed water flowed to the Frenchman Lake region of Area 5. However, the proposed project areas are in a region where flash flooding occurs due to locally isolated intense convection storms. These floods normally last less than 6 hours (NT DOE 1992d:4-27).

Surface Water Quality. There are no NPDES permits for the site as there are no wastewater discharges to onsite or offsite surface waters. However, the State has issued sewage discharge permits for sewage lagoons and ponds for NTS facilities. Because there are no surface waters at or near the proposed project area, and because there will be no withdrawal or discharge to natural surface waters at NTS, the assessment of surface water quality is not applicable.

Surface Water Rights and Permits. Surface water rights are not an issue because NTS facilities do not withdraw surface water for use nor do they discharge effluents directly to natural surface waters.

Groundwater. The NTS is located within three groundwater subbasins of the Death Valley Groundwater Basin. Groundwater beneath the eastern portion of NTS is located in the Ash Meadows Subbasin; the western portion is located in the Alkali Flat Furnace Creek Ranch Subbasin; and a small part of the northwestern corner is located in the Oasis Valley Subbasin (Figure 3.3.4–2). The actual subbasin boundaries, however, are poorly defined. Three general aquifers are present at NTS: the Lower Carbonate (the deepest), the Volcanic, and the Valley-Fill (the shallowest) (NT DOE 1992d:4-14). Other aquifers are present to a limited extent under the area, but their water-bearing potential has not been thoroughly investigated. Limited aquifers may occur in other volcanic units, including lava flows and bedded tuffs.

The Lower Carbonate is the regional aquifer and is comprised of carbonate rocks of Middle Cambrian through Devonian age. The saturated thickness of this confined aquifer ranges from approximately 100 m to over 1,000 m (328 ft to over 3,280 ft). This aquifer drains in a south-southwest direction, under Yucca and Frenchman Flats, toward Ash Meadows (NT DOE 1992d:4-14). However, due to the large topographic changes across the area and the importance of fractures to groundwater flow in this aquifer, local flow directions can vary significantly from this regional trend. The unconfined Volcanic and Valley-Fill aquifers range in thickness from close to 0 to about 610 m (2,000 ft) and occur in the Frenchman and Yucca Flats drainage basins, respectively (NT DOE 1992d:4-17).

Depth to groundwater at NTS ranges from approximately 150 m to over 700 m (492 ft to over 2,300 ft). It is approximately 490 m (1,607 ft) at Yucca Flat, 250 m (820 ft) at Frenchman Flat, and over 700 m (2,300 ft) at Pahute Mesa. However, there are areas of perched water that lie at considerably shallower depths.

Recent estimates of the perennial yield of all NTS aquifers (that is, the total amount that can be removed on an annual basis without resulting in a net depleting of the groundwater reservoir) range from 57 billion l (15 billion gal) (NT USGS 1988a) to 38 billion l (10 billion gal) (NT DOE 1992b:41-43). Groundwater is recharged from infiltration of precipitation in the northern and eastern mountain ranges and from underflow from upgradient areas. Natural discharge from the aquifers primarily occurs from evaporation and transpiration in the Amargosa Valley (including Ash Meadows) and Death Valley areas (Figure 3.3.4–2).

Devils Hole is a water-filled limestone cavern near Ash Meadows, approximately 48 km (29.8 mi) southwest of the NTS southern boundary, and is known to contain the endangered Devils Hole pupfish. Groundwater pumping at Ash Meadows was curtailed by order of the U.S. Supreme Court in order to protect the endangered Devils Hole pupfish by maintaining water levels at Devils Hole. Studies have shown, however, that historical pumping at NTS at rates that exceed current rates was probably unrelated to observed declines at Devils Hole (NT DOE 1993b:4-27).

Groundwater Quality. Currently, aquifers beneath NTS have not been classified by EPA. However, during an independent study (NT DOE 1989a:11), the aquifers beneath NTS were classified as Class IIa and Class IIb (groundwater currently used for drinking water). In 1972, the DOE Nevada Operations Office instituted a Long-Term Hydrological Monitoring Program to be operated by the EPA under an Interagency Agreement. Groundwater is monitored on and around NTS, and at two off-NTS sites in Nevada. Only wells drilled previously for water supply or exploratory purposes are being used in the monitoring program. In compliance with the SDWA and a State of Nevada drinking water supply system permit, drinking water wells and industrial use distribution systems are sampled and analyzed on a monthly basis. Groundwater samples collected are analyzed for a standard suite of parameters and constituents, including radioactive materials, nonradioactive materials, hydrogen-ion concentration (pH), total dissolved solids (TDS) and other field parameters.

Groundwater under portions of NTS has been affected as a result of nuclear testing activities conducted during the last 43 years. Additionally, 20 percent of the tests have been conducted below the water table or have been close enough that effects have extended below it. Table 3.3.4–1 shows the groundwater quality at NTS.

Table 3.3.4–1. Groundwater Quality Monitoring at Nevada Test Site, 1993

Parameter	Unit of Measure	Water Quality Criteria and Standards[a]	Potable Water Distribution System	
			High	Low
Alkalinity	mg/l	NA	270	64
Alpha (gross)	pCi/l	15[b]	11	0.62
Arsenic	mg/l	0.05[b]	0.012	<0.003[c]
Barium	mg/l	2.0[b]	0.15	0.00
Beta (gross)	pCi/l	50[d]	13	3.2
Chromium	mg/l	0.1[b]	<0.005[c]	<0.005[c]
Lead	mg/l	0.015[b]	<0.005[c]	<0.005[c]
Nitrate	mg/l	10[b]	6.8	1.2
pH	pH units	6.5-8.5[e]	8.66	7.70
Sodium	mg/l	NA	103	30
Total dissolved solids	mg/l	500[e]	639	283
Tritium	pCi/l	80,000[f]	120	0.93

[a] For comparison purposes only.
[b] National Primary Drinking Water Regulations (40 CFR 141).
[c] Below detection limit.
[d] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).
[e] National Secondary Drinking Water Regulations (40 CFR 143).
[f] DOE DCG for water (DOE Order 5400.5). DCG values are based on a committed effective dose of 100 mrem per year. However, because the drinking water maximum contaminant level is based on 4 mrem per year, the number listed is 4 percent of the DCG.
Note: NA=not applicable.
Source: NT DOE 1994b.

Due to the past nuclear testing activities at NTS, radionuclide monitoring has been an important component of the groundwater monitoring program at the site. In general, tritium is the only radionuclide that appears in sampled water. Samples collected in 1993 show tritium concentrations ranging from 120 pCi/l (454 pCi/gal), in a non-potable supply well located in the northwestern part of NTS, to 0.93 pCi/l (3.5 pCi/gal), in a potable supply well located in the southeastern part of NTS. Subsurface migration of tritium to offsite areas is possible, but the probability of tritium reaching offsite wells or springs is minimal. It is also thought that the Lower and Upper Carbonate aquifers would most likely be the aquifers in which tritium might migrate to offsite areas.

Groundwater Availability, Use, and Rights. Groundwater is the only local source of industrial and drinking water supply in the NTS area. Numerous production wells are located on NTS and distributed among various areas of the site. Figure 3.3.4–2 shows how the NTS water system has been divided into four water service areas (A, B, C, and D) based on the location of the water supply system and support facilities. Water usage on NTS is largely for potable, construction, and dust control purposes. Water supply wells at NTS draw water from the Lower and Upper Carbonate, the Volcanic, and the Valley-Fill aquifers. The total water usage in 1994 was 2,400 million l/yr (634 million gal/yr), of which 1.3 million l/yr (343.3 million gal/yr) were withdrawn from the Ash Meadows Subbasin, and 1,100 million l/yr (290.5 million gal/yr) were withdrawn from the Alkali Flat Furnace Creek Ranch Subbasin (Figure 3.3.4–2). The pumping capacity for all the water supply wells at NTS is estimated at 14,800 million l/yr (3,900 million gal/yr) (NTS 1993a:6).

The State of Nevada strictly controls all surface and groundwater withdrawals. The Appropriation Doctrine governs the acquisition and use of water rights. However, it is an established principle that when land is withdrawn from public use and reserved for Federal purposes, the Government's right to associated water may be implied. NTS has been withdrawn from public use and thus possesses an unqualified water right sufficient to meet the purposes of the NTS land withdrawal, subject to water rights that existed at the time the land for NTS was withdrawn.

Since the Federal Government has not waived its sovereign immunity with respect to Nevada's well drilling laws, it is not subject to these requirements. While DOE Nevada Operation Office is not legally required to follow Nevada water appropriation and well drilling requirements, there is no objection to responding to requests for information and cooperating in other respects with the Nevada Division of Water Resources as a gesture of goodwill.

3.3.5 GEOLOGY AND SOILS

Geology. The NTS is located in the southern part of the Great Basin section of the Basin and Range physiographic province in an intermediate position between the high, topographically closed basins in central Nevada and the low, connected basins of the Amargosa Desert-Death Valley region to the southwest. NTS consists of three flats (Yucca, Jackass, and Frenchman) surrounded by mountains. Local geology is characterized by mountains of Precambrian and Paleozoic sedimentary rocks and Tertiary volcanic tuffs and lavas. Sedimentary rocks are complex, folded, and faulted carbonates in the upper and lower parts and shale and sandstone in the middle section. Volcanic rocks are predominantly Tertiary tuffs with some basalts and scattered granitic plutons. Potential geologic resources within the NTS boundaries include silver, gold, tungsten, molybdenum, zeolites, barite, and fluorite.

The general region has been tectonically active in the recent past and has numerous faults. NTS lies in an area of moderate historic seismic activity on the southern margin of the southern Nevada, East-West Seismic Belt in Seismic Zones 2 and 3, indicating that moderate-to-major damage could occur as a result of an earthquake (Figure 3.3.5–1). More than 4,000 earthquakes have been recorded within a 241-km (150-mi) radius of NTS. Most of these were minor events, with Richter magnitudes of less than 5.5 and MMIs that may correlate to maximum ground acceleration of 0.03 gravity (Figure 3.3.5–1). The largest seismic event on record took place 161 km (100 mi) west in Owens Valley, California, and had an estimated Richter magnitude of 8.3 (NT DOE 1988a:3-117). On June 29, 1992, an earthquake of magnitude 5.6 occurred in the southwest corner of the site under Little Skull Mountain (Figure 3.3.5–1). The maximum ground acceleration from this earthquake was approximately 0.21 g at Amargosa Valley.

The Yucca and Carpetbag Faults were active during the Late Quaternary, and both are considered to be capable faults by the definition outlined in 10 CFR 100, Appendix A. The Yucca Fault has undergone surface rupture within the past few thousand to tens-of-thousands of years. Some earthquakes can be directly associated with the fault trace and also beyond the south end of the mapped section in the Yucca Pass, suggesting that the fault may continue in that direction. No significant vertical surface displacement has occurred on the Carpetbag Fault system during the past 150,000 years, but there is evidence of episodes of fracturing and possible minor faulting from 30,000 to 240,000 years ago, with average recurrence interval of about 25,000 years for the last 125,000 years. The Carpetbag Fault has been mapped in the subsurface beyond the southern end of Yucca Basin and may project to the northeast. Possible magnitude, intensity, and acceleration of earthquakes along the Yucca and Carpetbag Faults have not been estimated.

The Cane Spring Fault does not show Holocene displacement but is thought to have been the source of a 4.3 Richter magnitude earthquake in 1971. The maximum credible earthquake associated with the Cane Spring Fault is expected to produce a peak acceleration of 0.67 g with a 6.7 Richter magnitude. The recurrence interval is estimated to be 10,000 to 30,000 years. The Cane Spring Fault extends to the southwest and is connected in the deep subsurface to a third capable fault, the Rock Valley Fault, which has been the epicenter for several earthquakes of Richter magnitudes between 3 and 4 since 1992.

The most recent volcanic activity in the immediate area was 0.3 million years ago, and the likelihood for renewed activity in the next 10,000 years is slight (NT LANL 1983a:7). NTS lies approximately 241 km (150 mi) southeast of the Long Valley area of California, an area of potential volcanic eruption of the Mount St. Helens type.

Soils. Soils at NTS include three major types: shallow soils developed in the uplands and mountains; soils on valley fill and nearly-level-to-moderately sloping outwash plains, alluvial fans, and fan aprons; and playas and soils on nearly level flats and basins. Possible erosion hazards range from slight to severe while the shrink-swell potential ranges from low to high for some of these soils. The potential for wind erosion and shrink-swell increases in the playas and basins. The potential for water erosion increases with increasing slope. The soils at NTS are considered acceptable for standard construction techniques.

3.3.6 BIOLOGICAL RESOURCES

Terrestrial Resources. The NTS lies in a transition area between the Mojave and Great Basin Deserts. As a result, flora and fauna that are characteristic of both deserts are found within the site boundaries (NT ERDA 1976a:34). Approximately 33 km^2 (12.7 mi^2) of NTS have been developed, which represents about 1 percent of the site; thus, natural plant communities are found across most of NTS (NT DOE 1988d:3,4,6,7). The site has been divided into nine major plant communities, as shown in Figure 3.3.6–1.

Of the plant communities present onsite, the mountains, hills and mesas, sagebrush, creosote bush, and hopsage-desert thorn communities are the most extensive. Saltbush and desert thorn communities occupy more limited areas adjacent to the playas in Frenchman and Yucca Flats. Introduced plants such as red brome, cheatgrass, and Russian thistle have become important species in some areas. These plants rapidly invade disturbed areas and delay revegetation by native species (NT Hunter 1991a:1 of abstract). A total of 711 taxa of vascular plants have been identified on or near NTS (NT ERDA 1976a:34).

Terrestrial wildlife found on NTS includes 33 species of reptiles, 222 species of birds, and 49 species of mammals (NT Greger 1992a; NTS 1990a:1; NTS 1990a:2). Species common to NTS include the side-blotched lizard, western shovel-nosed snake, black-throated sparrow, red-tailed hawk, Merriam's kangaroo rat, and Great Basin pocket mouse. Water holes, both natural and manmade, are important to many species of wildlife, including game animals such as pronghorn and mule deer (NT Greger nda). Hunting is not permitted anywhere on NTS. Raptors such as the turkey vulture and rough-legged hawk, and carnivores such as the long-tailed weasel and bobcat, are two ecologically important groups on NTS. A variety of migratory birds has been found at NTS. Migratory birds, as well as their nests and eggs, are protected by the *Migratory Bird Treaty Act*. Eagles are similarly protected by the *Bald and Golden Eagle Protection Act.*

Vegetative cover in the area of Frenchman Flat proposed for the consolidated Pu storage facility (which is also the assumed analysis site for a number of disposition alternatives) falls primarily within the creosote bush community (Figure 3.3.6–1). Fauna found in this area would be expected to be closely associated with Mojave desert fauna, and species could include the banded gecko, desert iguana, Gambel's quail, greater roadrunner, round-tailed ground squirrel, and cactus mouse. Vegetation within the alternative consolidated Pu storage facility site (P-Tunnel location) falls within the mountains, hills, and mesas and blackbrush communities. Fauna found in this more northerly location would be most closely associated with Great Basin desert fauna. Animal species present could include the sagebrush lizard, western skink, Great Basin pocket mouse, and Great Basin kangaroo rat (NT ERDA 1976a:47,48,56).

Wetlands. The NWI maps of NTS have not been prepared nor have wetlands been delineated on the site. However, small wetland areas (less than 0.4 ha [1 acre]) may be associated with NTS springs (NTS 1992a:5). There are no known wetlands in either of the proposed storage facility sites.

Aquatic Resources. Potential aquatic habitat on NTS includes surface drainages, playas, springs, and manmade reservoirs. There are no continuously flowing streams on the site and permanent surface water sources are limited to a few small springs. These surface drainages, playas, and springs are unable to support permanent fish populations (DOE 1995w:2.4-61,2.4-62). Manmade water reservoirs located throughout the site support three introduced species of fish: bluegill, goldfish, and golden shiners (NTS 1992a:6). There are no known aquatic resources in either of the proposed storage facility sites.

Threatened and Endangered Species. There are nine federally and State-listed threatened, endangered, and other special status species found in the vicinity of NTS. Eight of these are federally or State-listed as threatened or endangered or protected under State law (Table 3.3.6–1). Eight species listed in Table 3.3.6–1 have been observed on NTS. Once specific project locations have been determined, site surveys will verify the presence of special status species. No critical habitat for threatened or endangered species, as defined in the ESA (50 CFR 17.11; 50 CFR 17.12), exists on NTS.

Table 3.3.6–1. Federally and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found on or in the Vicinity of Nevada Test Site

Common Name	Scientific Name	Status[a] Federal	Status[a] State
Mammal			
[Text deleted.]			
Spotted bat[b]	*Euderma maculatum*	NL	T
[Text deleted.]			
Birds			
American peregrine falcon[c,d]	*Falco peregrinus anatum*	E	T
Arctic peregrine falcon[c]	*Falco peregrinus tundrius*	E(S/A)	T
Bald eagle[b,d]	*Haliaeetus leucocephalus*	T	T
[Text deleted.]			
Mountain plover[b]	*Charadrius montanus*	C	NL
[Text deleted.]			
Reptiles			
[Text deleted.]			
Desert tortoise [b,e]	*Gopherus agassizii*	T	T
Fish			
Devils Hole pupfish[d,f]	*Cyprinodon diabolis*	E	E
Plants			
[Text deleted.]			
Beatley milkvetch[b]	*Astragalus beatleyae*	NL	CE
[Text deleted.]			
Mojave fishhook cactus[b]	*Sclerocactus polyancistrus*	NL	CY
[Text deleted.]			

[a] Status codes: C=Federal candidate; CE=critically endangered by authority of NRS 527.270 (State Division of Forestry); CY=protected by authority of NRS 522.60–.120 (Nevada Cacti and Yucca Law); E=endangered; NL=not listed; S/A=protected under the similarity of appearances provision of the ESA; T=threatened.

[b] Species recorded on NTS.

[c] Peregrine falcon seen on NTS; however not identified to subspecies level.

[d] USFWS Recovery Plan exists for this species.

[e] Species known to occur on the proposed new consolidated storage facility site.

[f] Only known location of this species is outside the NTS 48.3 km southwest of the proposed new consolidated storage facility site. This species is included here due to offsite groundwater concerns.

Note: Nevada Department of Wildlife is currently revising the state threatened and endangered species list.

Source: 50 CFR 17.11; 50 CFR 17.12; 61 FR 7596; DOE 1995w; NT DOE 1995j; NT DOE 1996c; NT DOI 1995a; NT ERDA 1976a; NV FWS 1989a; NV NHP 1995a.

The federally and State-listed peregrine falcon and bald eagle are considered rare migrants to NTS. The threatened desert tortoise is the only resident species known to inhabit NTS that is protected under ESA. The range of the desert tortoise lies in the southern third of the site (Figure 3.3.6–2). The abundance of tortoises on NTS is considered low to very low relative to other areas within this species' geographic range. Densities of tortoises on NTS range from 0 to 17 individuals per square kilometer (0 to 45 individuals per square mile), with most habitats probably having densities of 0 to 8 individuals per square kilometer (0 to 20 individuals per square mile) (NT DOE 1991b:3-23). The only known population of the Devils Hole pupfish lives in Devils Hole, a water-filled limestone cavern in Ash Meadows, approximately 48 km (29.8 mi) southwest of NTS. There is concern over the survival of the pupfish and other sensitive species found in the Ash Meadows area due to the threat of declining water levels (NT DOI 1991a:1,4-6; NT ERDA 1977a:2-134,2-135,4-28,4-29).

Table 3.3.6–1 identifies two State-protected plant species at NTS. [Text deleted.] The Federal-candidate mountain plover is a migrant species that has also been observed onsite. Although their distribution is unclear, the spotted bat has been recorded on NTS (Table 3.3.6–1).

The area within Frenchman Flat proposed for storage facilities (which is also the assumed analysis site for a number of disposition alternatives) is within the range of the desert tortoise. Both tortoise remains and scat have been observed in the proposed site area (NT EG&G 1991a:14,15,31). The alternate storage facility location (P-Tunnel project location) lies far north of the desert tortoise range. Occurrence of other special status species around the proposed project locations is unknown.

3.3.7 CULTURAL AND PALEONTOLOGICAL RESOURCES

Prehistoric Resources. [Text deleted.] Prehistoric site types identified on NTS include habitation sites with wood and brush structures, windbreaks, rock rings, and cleared areas; rockshelters; petroglyphs (rock art); hunting blinds; rock alignments; quarries; temporary camps; milling stations; roasting ovens or pits; water caches; and limited activity locations. Milling stations are especially prevalent near the Yucca Lake playa margins. Several prehistoric rockshelters have been identified on Hogback Ridge. Approximately 6 percent of NTS has been inventoried for cultural resources. This includes all lands managed through a Memorandum of Agreement with Nellis Air Force Base. Excluding sites in the Yucca Mountain project area, approximately 1,600 prehistoric sites have been recorded. Hundreds of prehistoric sites have been identified in both Yucca Flat and Frenchman Flat; some of which may be eligible for listing on the NRHP. Additional prehistoric sites may occur in unsurveyed portions of NTS.

Historic Resources. Historic site types on NTS include mines and prospects, trash dumps, settlements, campsites, ranches, homesteads, developed spring heads, roads, trails, and nuclear weapons development sites. Historic resources associated with nuclear testing are common in both Yucca and Frenchman Flats. Nuclear test site structures and associated debris, including instrumentation stands and temporary storage bunkers, are also located within NTS. The test site area at Frenchman Flat, which includes the remains of many of these structures, has been recommended to the SHPO as a historic district. Excluding the Yucca Mountain project area, over 60 historic sites have been recorded. The only site currently listed on the NRHP is Sedan Crater. The crater was created in 1962 as part of the Plowshare Program, whose aim was to identify peaceful uses for nuclear explosions. It is located in Yucca Flat. The Emigrant Trail used by the "49ers" that traverses the southwestern corner of NTS is considered eligible for inclusion on the NRHP. Additional historic sites may occur in unsurveyed portions of NTS.

Native American Resources. The lands and resources of NTS have held an important place in the lives of Native Americans for centuries, and the area has been used continuously by many tribes. At the time of European-American contact, southern Nevada was inhabited by the Western Shoshone and the Southern Pahute. These peoples lived together in small groups from the spring through the fall. During winter, villages composed of several families were established in warmer places, close to preserves of pine nuts, seeds, and dried meats. Groups came to NTS from a broad region during the hunting season and relied on both animal and plant resources there that were crucial for their survival and cultural practices.

The NTS contains numerous ceremonial resources and power places that are critical for the continuation of Native American culture, religion, and society. Until the mid-1900s, traditional festivals involving religious and secular activities attracted Native American people to the area from as far as western California. There are numerous resources at NTS that are important to Native American groups. These resources include burials, ceremonial sites, musical stones, medicine rocks, petroglyphs, and traditional use areas. Local plants important in ritual and ceremonial activities include jimsonweed, juniper, greasewood, creosote, Indian tobacco, piñon pine, buckbush, and scrub oak. Concern has been expressed about the availability and accessibility of such resources.

Consultation with Native American cultural and religious leaders has been conducted for other projects at or near NTS to identify traditional cultural resources that may be affected by Federal actions and to obtain Native American recommendations for mitigating potential impacts on traditional cultural resources. DOE has established ongoing consultation with 17 Native American tribal organizations that have cultural ties to NTS. According to the American Indian Writers Subgroup of the Consolidated Group of Tribes and Organizations (CGTO), despite the loss of some traditional lands to pollution and reduced access, the Native American people have neither lost their ancestral ties to nor have forgotten their cultural resources on NTS. There is continuity in the Native American use of and broad cultural ties to NTS. Native American people continue to value and recognize the central role of these lands in their continued survival (NT DOE 1996c:4-162).

Paleontological Resources. The surface geology of NTS is characterized by alluvium-filled valleys surrounded by ranges composed of Precambrian and Paleozoic sedimentary rocks and Tertiary volcanic tuffs and lavas. The Precambrian and Paleozoic rocks at NTS represent relic deposits made in shallow water at the submerged edge of a continental platform that ran from Mexico to Alaska and existed throughout most of the Paleozoic. Although the Precambrian sedimentary deposits contain no fossils or only a few poorly preserved fossils, the Paleozoic marine limestones are moderately to abundantly fossiliferous. Marine fossils found in the same Paleozoic formations on Nellis Air Force Range, adjacent to NTS to the north, include trilobites, conodonts, ostracods, solitary and colonial corals, brachiopods, algae, gastropods, and archaic fish. These fossils, however, are relatively common and have low research potential.

Tertiary volcanic deposits are not expected to contain fossils; however, the Late Pleistocene terrestrial vertebrate fossils of the Rancholabrean Land Mammal Age could be expected in the Quaternary deposits. The possibility of finding mammoth, horse, camel, and bison remains might be expected because such fossils have been found at Tule Springs, 56 km (35 mi) from the southern edge of NTS, and in Nye Canyon. Fossils found at Tule Springs include bison, deer, a small donkey-like horse, camel, Columbia mammoth, ground sloth, giant jaguar, bobcat, coyote, muskrat, and a variety of rabbits, rodents, and birds. This paleontological assemblage has high research potential. Although no known fossil localities have been recorded to date, Quaternary deposits with paleontological materials may occur on NTS. Other Pleistocene resources include pack rat middens, which are studied by scientists at the University of Nevada, Reno, the Desert Research Institute, and the New Mexico Institute of Mines and Technology to investigate paleoclimatic regimes.

3.3.8 SOCIOECONOMICS

Socioeconomic characteristics described for NTS include employment, regional economy, population, housing, community services, and local transportation. Statistics for employment and regional economy are presented for the REA that encompasses 11 counties surrounding NTS in Nevada, Arizona, and Utah (Table L.1–1). Statistics for population, housing, community services, and local transportation are presented for the ROI, a two-county area in which 97 percent of all NTS employees reside: Clark County (82 percent) and Nye County (15 percent). In 1991, NTS employed approximately 7,700 persons (2.1 percent of the total REA employment) (Table L.1–3). [Text deleted.]

Regional Economy Characteristics. Selected employment and regional economy statistics for the REA are summarized in Figure 3.3.8–1. The civilian labor force in the REA increased approximately 64 percent between 1980 and 1990, reaching 506,394 in the latter year. Total employment in the REA was 587,533 in 1994. In that year, the regional unemployment rate in the REA was 6.1 percent, comparable to the rate in Arizona (6.4 percent) and Nevada (6.2 percent), but much higher than the rate in Utah (3.7 percent). The 1993 per capita income in the REA was $20,561, lower than Nevada's per capita income of $22,727, but higher than the per capita income in Arizona or Utah, $18,085 and $16,354, respectively.

Employment patterns in the REA parallel those in Arizona, Nevada, and Utah, with manufacturing, retail trade, and service providing the majority of nonfarm private sector jobs. The service sector is the primary source of employment in both the REA and Nevada providing 43.5 percent and 43.4 percent of jobs, respectively. This sector is less dominant in Arizona and Utah, accounting for 30.2 percent and 28.6 percent of total employment in those states, respectively.

Population and Housing. Population and housing trends in the ROI are summarized in Figure 3.3.8–2. Population in the ROI increased 103.4 percent between 1980 and 1994, reaching 960,088 at the end of the period. This rate of increase surpassed Nevada's population growth of 82.0 percent during the same period.

The total number of housing units in the ROI also increased significantly between 1980 and 1990, increasing by 65.9 percent compared to a 52.6 percent increase within Nevada. In 1990, homeowner and renter vacancy rates in the NTS ROI were similar to those in Nevada, approximately 2 percent and 9 percent, respectively.

Community Services. Community services described for the NTS ROI are education, public safety, and health care. Figure 3.3.8–3 presents school district characteristics for the NTS ROI, and Figure 3.3.8–4 presents public safety and health care characteristics.

Education. Two school districts provide public education services and facilities in the NTS ROI. During the 1994-95 school year, the Nye County School District had an enrollment of 4,170 students while the Clark School District had an enrollment of 156,348 students. The two school districts operated at 85 and 100 percent of capacity, respectively, as shown in Figure 3.3.8–3. The average student-to-teacher ratio in the ROI was 19.6:1.

Public Safety. Five city and county law enforcement agencies provide police protection in the ROI. In 1994, the highest ratio of sworn officer-to-population in the two-county region was in Nye County, with 3.3 officers per 1,000 persons. The average ROI officer-to-population ratio was 2.0 officers per 1,000 persons. [Text deleted.]

During 1995, a total of 1,505 regular and volunteer firefighters provided fire protection services to the ROI. The rural county departments include both professional and volunteer staff, while the city districts are exclusively professional. Among the firefighting departments, the Nye County Fire Department has the highest firefighter-to-population ratio with 6.1 firefighters per 1,000 persons, although most of the firefighters are volunteers (Figure 3.3.8–4). [Text deleted.] The average ROI firefighter-to-population ratio was 1.6 firefighters per 1,000 persons.

Health Care. Nine hospitals serve the two-county region, all operating well below capacity. In 1994, a total of 1,244 physicians served the ROI. Figure 3.3.8–4 shows that the physician-to-population ratio ranged from 0.3 physicians per 1,000 persons in Nye County to 1.3 physicians per 1,000 persons in Clark County. The ROI average physician-to-population ratio was 1.3 physicians per 1,000 persons. The hospital bed-to-population ratio ranged from 2.1 beds per 1,000 persons in Nye County to 2.4 beds per 1,000 persons in Clark County.

Local Transportation. Vehicular access to NTS is provided by U.S. Route 95 to the south (see Figure 2.2.2–1 and Figure 2.2.2–2). [Text deleted.] Road segments providing access to NTS experience little traffic congestion outside of the Las Vegas metropolitan area. There are no current or planned road improvement projects that would affect access to NTS (NV DOT 1995a:1).

Two road segments in the ROI could be affected by the storage and disposition alternatives. The first is U.S. 95 from Business Route U.S. 95 to just south of Nevada State Route 160. This segment operated at level of service A in 1995. The second is U.S. 95 from just south of Nevada State Route 160 to just south of Nevada State Route 266. This segment operated at level of service C in 1995.

Although there is no public transportation system serving NTS, a contract bus service for workers is available at a nominal cost. The major railroad in the ROI is the Union Pacific Railroad located approximately 80 km (50 mi) east of NTS near Las Vegas. There are no navigable waterways within the ROI.

McCarran International Airport in Las Vegas provides jet air passenger and cargo service from both national and local carriers. Numerous smaller private airports are located throughout the ROI.

3.3.9 PUBLIC AND OCCUPATIONAL HEALTH AND SAFETY

Radiation Environment. Major sources and levels of background radiation exposure to individuals in the vicinity of NTS are shown in Table 3.3.9–1. Annual background radiation doses to individuals are expected to remain constant over time. The total dose to the population changes as the population size changes. Background radiation doses are unrelated to NTS operations.

Table 3.3.9–1. Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Nevada Test Site Operation

Source	Effective Dose Equivalent (mrem/yr)
Natural Background Radiation	
Cosmic and external terrestrial radiation[a]	74
Internal terrestrial radiation[b]	39
Radon in homes (inhaled)[b]	200
Other Background Radiation[b]	
Diagnostic x rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	378

[a] Derived from information on cosmic and terrestrial radiation given in EPA 1981b.
[b] NCRP 1987a.
Note: Value for radon is an average for the United States.

Releases of radionuclides to the environment from NTS operations provide another source of radiation exposure to individuals in the vicinity of NTS. Types and quantities of radionuclides released from NTS operations in 1993 are listed in the *U.S. Department of Energy Nevada Operations Office Annual Site Environment Report–1993* (DOE/NV/11432-123). The doses to the public resulting from these releases are presented in Table 3.3.9–2. These doses fall within radiological limits (DOE Order 5400.5) and are small in comparison to background radiation. The releases listed in the 1993 report were used in the development of the reference environment's (No Action) radiological releases and resulting impacts at NTS in the year 2005 (Section 4.2.2.9).

Based on a risk estimator of 500 cancer deaths per 1 million person-rem to the public (Section M.2.1.2), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from NTS operations in 1993 is estimated to be 2.4×10^{-9}. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of NTS operations is about 2 chances in 1 billion. (Note that it takes several to many years from the time of radiation exposure for a cancer to manifest itself.)

Based on the same risk estimator, 6×10^{-6} excess fatal cancers are projected in the population living within 80 km (50 mi) of NTS from normal operations in 1993. To place this number into perspective, it can be compared with the number of fatal cancers expected in this population from all causes. The 1990 mortality rate associated with cancer for the entire U.S. population was 0.2 percent per year (Almanac 1993a:839). Based on this national rate, the number of fatal cancers expected during 1993 from all causes in the population living within 80 km (50 mi) of NTS was 44. This number of expected fatal cancers is much higher than the estimated 6×10^{-6} fatal cancers that could result from NTS operation in 1993.

Table 3.3.9–2. Radiation Doses to the Public From Normal Nevada Test Site Operation in 1993 (Committed Effective Dose Equivalent)

Members of the General Public	Atmospheric Releases		Liquid Releases		Total	
	Standard[a]	Actual	Standard[a]	Actual	Standard[a]	Actual
Maximally exposed individual (mrem)	10	0.0048	4	0	100	0.0048
Population within 80 km[b] (person-rem)	None	0.012	None	0	100	0.012
Average individual within 80 km[c] (mrem)	None	5.5×10^{-4}	None	0	None	5.5×10^{-4}

[a] The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10 mrem/yr limit from airborne emissions is required by the CAA, the 4 mrem/yr limit is required by the SDWA, and the total dose of 100 mrem/yr is the limit from all pathways combined. The 100 person-rem value for the population is given in proposed 10 CFR 834 (see 58 FR 16268). If the potential total dose exceeds this value, it is required that the contractor operating the facility notify DOE.

[b] In 1993, this population was approximately 21,750.

[c] Obtained by dividing the population dose by the number of people living within 80 km of the site.

Source: NT DOE 1994b.

The NTS workers receive the same dose as the general public from background radiation, but also receive an additional dose from working in the facilities. Table 3.3.9–3 presents the average worker, maximally exposed worker, and total cumulative worker dose to NTS workers from operation in 1992. These doses fall within radiological regulatory limits (10 CFR 835). Based on a risk estimator of 400 fatal cancers per 1 million person-rem among workers (Section M.2.1.2), the number of fatal cancers to NTS workers from normal operation in 1992 is estimated to be 0.0008.

Table 3.3.9–3. Radiation Doses to Workers From Normal Nevada Test Site Operation in 1992 (Committed Effective Dose Equivalent)

Occupational Personnel	Onsite Releases and Direct Radiation	
	Standard[a]	Actual
Average worker (mrem)	ALARA	2.6
Maximally exposed worker (mrem)	5,000	750
Total workers[b] (person-rem)	ALARA	2

[a] DOE's goal is to maintain radiological exposure as low as reasonably achievable.

[b] The number of badged workers in 1992 was approximately 780.

Source: 10 CFR 835; DOE 1993n:7.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the *U.S. Department of Energy Nevada Operations Office Annual Site Environment Report–1993* (DOE/NV/11432-123). The concentrations of radioactivity in various environmental media (including air and water) and in animal tissue in the site region (onsite and offsite) are also presented in the same document.

Chemical Environment. The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (for example, soil through direct contact or via the food pathway). The baseline data for assessing potential health impacts from the chemical environment are those presented in Section 3.3.3.

Effective administrative and design controls that decrease hazardous chemical releases to the environment and help achieve compliance with permit requirements (for example, air emissions and NPDES permit requirements), contribute toward minimizing potential health impacts to the public. The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts to the public may occur during normal operations at NTS via inhalation of air containing hazardous chemicals released to the atmosphere by NTS operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water or direct exposure, are low relative to the inhalation pathway.

Baseline air emission concentrations for hazardous chemicals and their applicable standards are included in the data presented in Section 3.3.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are in compliance with applicable guidelines and regulations. Information about estimating health impacts from hazardous chemicals is presented in Section M.3.

Exposure pathways to NTS workers during normal operations may include inhaling the workplace atmosphere and direct contact with hazardous materials associated with work assignments. The potential for health impacts varies from facility to facility and from worker to worker, and available information is not sufficient to allow a meaningful estimation and summation of these impacts. However, workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. NTS workers are also protected by adherence to OSHA and EPA standards that limit atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring that reflects the frequency and amounts of chemicals utilized in the operation processes ensures that these standards are not exceeded. Additionally, DOE requirements ensure that conditions in the workplace are as free as possible from recognized hazards that cause, or are likely to cause, illness or physical harm. Therefore, worker health conditions at NTS are expected to be substantially better than required by standards.

Health Effects Studies. The epidemiologic studies on groups surrounding NTS have concentrated on health effects in soldiers and children associated with nuclear testing rather than operation emissions. Results are contradictory regarding the observed leukemia incidence and deaths in exposed children, with some studies reporting excess, whereas others report no excess. Analytical methods used in some of these studies were questionable. For soldiers, the results regarding leukemia and polycythemia vera differ from two studies relating to nuclear test explosions. However, reanalyses showed leukemia, respiratory, and other cancers to be associated only with exposure to higher doses (for example, more than 300 millirem [mrem] for leukemia cases). For a more detailed description of the study findings reviewed, refer to Section M.4.3.

Accident History. Nuclear testing began at NTS in 1951. There were some 100 atmospheric nuclear explosions before the Limited Test Ban Treaty was implemented in 1963. Since then, all nuclear tests have been conducted underground.

Since 1970, there have been 126 nuclear tests, which resulted in a release to the atmosphere of approximately 54,000 Curies (Ci) of radioactivity. Of this amount, 11,500 Ci were accidental due to containment failure (massive releases or seeps) and late-time seeps (small releases after a test when gases diffuse through pore spaces of the overlying rock). The remaining 42,500 Ci were operational releases. From the perspective of human health risk, if the same person had been standing at the boundary of NTS in the area of maximum concentration of radioactivity for every test since 1970, that person's total exposure would be equivalent to 32 extra minutes of normal background exposure, or the equivalent of one-thousandth of a single chest x ray (OTA 1989a:4,5). [Text deleted.]

Emergency Preparedness. Each DOE site has established an emergency management program that would be activated in the event of an accident. This program has been developed and maintained to ensure adequate response for most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program incorporates activities associated with emergency planning, preparedness, and response.

The *NTS Emergency Preparedness Plan* is designed to minimize or mitigate the impact of any emergency upon the health and safety of employees and the public. The plan integrates all emergency planning into a single entity to minimize overlap and duplication and to ensure proper responses to emergencies not covered by a plan or directive. The manager of the DOE Nevada Operations Office has the responsibility to manage, counter, and recover from an emergency occurring at NTS.

The plan provides for identification and notification of personnel for any emergency that may devélop during operational and nonoperational hours. The Nevada Operations Office receives warnings, weather advisories, and any other communications that provide advance warning of a possible emergency. The plan is based upon current DOE Nevada Operations Office vulnerability assessments, resources, and capabilities regarding emergency preparedness.

3.3.10 WASTE MANAGEMENT

This section outlines the major environmental regulatory structure and ongoing waste management activities for NTS. A more detailed discussion of the ongoing waste management operations is provided in Section E.2.2. Table 3.3.10–1 presents a summary of waste management activities at NTS for 1993.

The Department is working with Federal and State regulatory authorities to address compliance and cleanup obligations rising from its past operations at NTS. The Department 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.

The Department has decided that underground testing areas should be governed pursuant to the provisions of CERCLA. Preliminary Assessment/Site Investigation Reports and a Hazardous Ranking System package were provided to the EPA for use in determining whether or not NTS should be included on the NPL. In May 1993, the State of Nevada issued a letter to DOE indicating it did not appear that EPA would make a decision on the NPL status of the NTS in the near future. DOE has published the *NTS Site Treatment Plan* and *Federal Facility Compliance Act Consent Order* addressing environmental restoration and waste management on NTS. A mutual consent agreement between the State of Nevada and DOE, updated in June 1995, permits NTS to use the available capacity of the TRU Waste Storage Pad for the storage of onsite generated mixed waste that does not meet RCRA land disposal provisions.

The DOE Nevada Operations Office completed a waste minimization plan for NTS in 1991 and created an organization whose mission is to promote waste minimization and pollution prevention and to ensure compliance with DOE requirements. NTS currently generates waste from ongoing operations and remediation associated with past activities and receives waste from other DOE facilities. NTS manages the following waste categories: TRU, low-level, mixed, hazardous, and nonhazardous. A discussion of the waste management operations associated with each of these categories follows.

Spent Nuclear Fuel. The NTS does not generate or manage spent nuclear fuel.

High-Level Waste. The NTS does not generate or manage HLW.

Transuranic Waste. From 1974 to 1990, 612 m^3 (800 cubic yards [yd^3]) of mixed TRU waste was received from LLNL and is stored on an 8,300-m^2 (89,300-ft^2) asphalt storage pad at Area 5 of NTS (NT REECO 1995a:21). DOE and the State of Nevada signed a Settlement Agreement and NTS received a RCRA Part B Permit in July, 1992, allowing the DOE Nevada Operations Office to retain this inventory of mixed TRU waste subject to an appropriate permitting process. None of these waste packages are WIPP-certified. They will have to be certified before shipment to WIPP depending on decisions made in the ROD associated with the supplemental EIS being prepared for the proposed continued phased development of WIPP for disposal of TRU waste. These wastes have been moved to a 1,995-m^2 (21,470-ft^2) polyvinyl chloride-coated polyester fabric-covered building for storage until WIPP is determined to be a suitable disposal facility pursuant to the requirements of 40 CFR 191 and 40 CFR 268 (NT DOE 1996b:BV-38). If WIPP is suitable, this mixed TRU waste will not have to be treated before disposal. NTS has areas of Pu-contaminated soil for which treatment technology is being developed. This activity may produce additional volumes of TRU or mixed TRU waste.

Low-Level Waste. In eight areas at NTS, LLW has been generated and disposed of, but currently only Areas 3 and 5 are active for disposal. Bulk waste is disposed of in Area 3, and packaged classified and unclassified waste is disposed of in Area 5. Disposal of onsite waste began in 1971, and in 1978 operations expanded to receive wastes generated offsite. In 1995, 15 generators shipped LLW to NTS for disposal. An additional 9 generators are applying or awaiting for approval (NT DOE 1996c:4-48,4-49). As of September 1994, approximately 300,000 m^3 (392,000 yd^3) in Area 3 (NT DOE 1996c:4-33) and, as of December 1993, approximately

Table 3.3.10–1. Waste Management Activities at Nevada Test Site

Category	1993 Generation (m^3)	Treatment Method	Treatment Capacity (m^3/yr)	Storage Method	Storage Capacity (m^3)	Disposal Method	Disposal Capacity (m^3)
Transuranic[a]	None	None	None	Containers on covered asphalt pad	612[b]	None–WIPP or alternate facility in the future	NA
Low-Level							
Liquid	Included in solid	None	None	None	None	None	None[c]
Solid	178[d]	None	None	None	None	Shallow burial and greater confinement	500,000[e]
Mixed Low-Level							
Liquid	None	None	None	Containers on TRU waste storage pad	1,150	None	None
Solid	None	None	None	Containers on TRU waste storage pad.	Same as liquid	Shallow burial	90,626[f]
Hazardous							
Liquid	34.6[g]	None	Planned	RCRA-permitted storage	62[h]	Contracted offsite	NA
Solid	Included in liquid[i]	None	None	RCRA-permitted storage	Included in liquid	Contracted offsite	NA
Nonhazardous (Sanitary)							
Liquid	Included in solid	Septic fields	As required	None	None	Septic fields	As required
Solid	7,170[g]	None	None	None	None	Landfill (onsite)	Expandable as required: as of November 1994, 459,000 m^3 available[j]
Nonhazardous (Other)							
Liquid	Included in sanitary	Septic fields	As required	None	None	Septic fields	As required
Solid	Included in sanitary	None	None	None	None	Landfill (onsite)	Expandable as required

[a] All TRU waste at NTS is considered to be mixed until further characterization is completed.
[b] 612 m^3 TRU (LLNL waste) stored pending WIPP availability. An additional capacity of 528 m^3 is available for mixed LLW storage.
[c] 408 m^3 was previously disposed, but liquid LLW is no longer disposed.
[d] Additional volume of LLW disposed of from on and offsite locations was 18,604 m^3.
[e] Area 3 and 5.
[f] Pit 3, Area 5 RWMS.
[g] Assumes a density factor of 1.0 t/m^3.
[h] Area 5 Hazardous Waste Storage Unit.
[i] Includes 2.5 m^3 TSCA waste.
[j] Disposal capacity is composed of three landfills.
Note: NA=not applicable.
Source: DOE 1995w; NT DOE 1994f; NT DOE 1996b; NT REECO 1994a; NT REECO 1995a; NTS 1993a:4; NTS 1995a:3.

167,400 m^3 (218,900 yd^3) in Area 5 (NT REECO 1994a:12) of LLW have been disposed of. Standard shallow land burial techniques have been employed.

Mixed Low-Level Waste. Disposal of mixed waste received from RFETS has taken place at NTS. Environmental restoration at NTS facilities could generate additional volumes of mixed wastes which will require some form of treatment. Mixed waste generated in the State of Nevada that meets land disposal restrictions of RCRA can be disposed of in the Area 5 Mixed Waste Disposal Unit, Pit 3. [Text deleted.] The Nevada Division of Environmental Protection provides RCRA oversight for NTS. The 1992 revised RCRA Part B Permit application, to include a separate mixed waste storage and disposal unit at NTS, in accordance with the provisions of the *Federal Facility Compliance Act*, has been submitted to the State of Nevada. A mutual consent agreement between the State of Nevada and DOE permits the storage of mixed LLW on the TRU waste storage pads. DOE has published the *NTS Site Treatment Plan* and *Federal Facility Compliance Act Consent Order* that establishes the basis for mixed LLW treatment, storage, and disposal at NTS.

Hazardous Waste. Hazardous wastes result from ongoing operations that utilize solvents, lubricants, fuel, Pb, metals, motor oil, and acids. Hazardous wastes are accumulated at satellite areas, stored at the Area 5 RCRA-permitted hazardous waste storage unit, and shipped offsite by truck using DOT-approved transporters to a commercial RCRA-permitted facility. Additional accumulation areas and new equipment are planned to prevent the possibility of cross contamination with radioactive wastes (creating mixed wastes) in handling these materials. PCB-contaminated waste is accumulated and stored in the Area 6 *Toxic Substances Control Act* (TSCA) Waste Accumulation Unit. Accumulated PCB waste is shipped offsite to a commercial TSCA treatment, storage, and disposal facility. Hazardous waste generation is decreasing as the result of an aggressive waste minimization program and will substantially decrease in the future due to the present moratorium on nuclear testing.

Nonhazardous Waste. Nonhazardous sanitary wastes are expected to be generated at the current rates for several years into the future, then decline assuming the present moratorium on underground weapons testing continues. Liquid nonhazardous wastes are disposed of in septic tanks, sumps, or in ponds; solid wastes are disposed of in landfills at various locations on the site. Recycling of paper, metals, glass, plastics, and cardboard has already resulted in some decreases in waste quantities. Solid waste landfills located in Areas 6, 9, and 23 are in use for the disposal of solid nonhazardous wastes. The Area 6 landfill is a Class III landfill that accepts hydrocarbon-burdened soil and debris. The Area 9 landfill is a Class II landfill as it accepts less than 18 t (20 tons) of solid waste per day. The Area 9 landfill is allowed to receive all types of nonhazardous solid waste, excluding radioactive waste, free liquids, and asbestos. Its current capacity is approximately 990,000 m^3 (1.3 million yd^3). Due to changes in State regulatory requirements, the Area 9 landfill will undergo partial closure and reopen as a Class III construction and demolition landfill. The Area 23 landfill receives all types of nonhazardous solid waste with nonpathogenic hospital waste, dead animals, and asbestos-containing materials being buried in separate cells that are identified by concrete markers. The current capacity is approximately 450,000 m^3 (589,000 yd^3). The Area 23 landfill is scheduled to remain in operation as a Class II landfill after modification to comply with the new State regulations (NT DOE 1996c:4-37).

3.4 IDAHO NATIONAL ENGINEERING LABORATORY

The Idaho National Engineering Laboratory is located in southeastern Idaho near Idaho Falls (Figure 2.2.3–1). The main site is 55 km (34 mi) west of Idaho Falls, 61 km (38 mi) northwest of Blackfoot, and 35 km (22 mi) east of Arco. There are also DOE activities in Idaho Falls. The facility has approximately 445 km (277 mi) of roads, both paved and unpaved, and 48 km (30 mi) of railroad track.

There are 450 buildings and 2,000 support structures at INEL with more than 279,000 m^2 (3,000,000 ft^2) of floor space in varying conditions of utility (Figure 2.2.3–2). INEL has approximately 25,100 m^2 (270,000 ft^2) of covered warehouse space and an additional 18,600 m^2 (200,000 ft^2) of fenced yard space. The total area of the various machine shops is 3,035 m^2 (32,665 ft^2).

There have been 52 research and test reactors at INEL used over the years to test reactor systems, fuel and target design, and overall safety. In addition to its nuclear reactor research, other INEL facilities are operated to support nuclear operations. These facilities include HLW and LLW processing and storage sites, hot cells, analytical laboratories, machine shops, laundry, railroad, and administrative facilities. Other activities include management of one of DOE's largest storage sites for LLW and TRU waste. Until 1992, spent reactor fuels were reprocessed at the ICPP to recover enriched uranium and other isotopes. Due to a DOE decision to terminate spent fuel reprocessing, the ICPP was transferred to the DOE Office of Environmental Management (EM) Program for disposition. The ICPP contains the waste calcination facility, which processes liquid HLW streams to a calcined solid (granular form). Beginning in the early part of the next century, the waste immobilization facility will convert the calcined solids into a glass ceramic for ultimate disposal in a Federal repository. Additionally, miscellaneous spent fuel from both DOE and commercial sources is scheduled for interim storage at the ICPP. Within the existing security perimeter, the Fuel Processing Restoration Facility is a special nuclear material storage and processing facility that is 95-percent complete and has never been operated.

Department activities at INEL have been divided among eight distinct and geographically separate function areas as listed in Table 3.4–1. The current functions at INEL can be further grouped into two major categories: EM activities and other DOE activities.

Department of Energy Activities. Environmental management activities include R&D for waste processing at the Power Burst Facility and providing waste management expertise to the RWMC. The Power Burst Facility supports facilities in R&D for waste reduction programs and the Boron Neutron Capture Therapy Program. Waste management efforts at INEL are directed toward safe and environmentally sound treatment, storage, and disposal of radioactive, hazardous, and sanitary waste generated from facility operations. Major waste reduction facilities include the Waste Engineering Development Facility, the Waste Experimental Reduction Facility, and the Mixed Waste Storage Facility.

The following additional DOE activities are located at INEL (see Figure 2.2.3–2):

- The Test Area North (TAN) complex is the northernmost facility within INEL and consists of several experimental reactors and support facilities conducting R&D activities on reactor performance. These facilities include the technical support facility, the containment test facility, the water reactor research test facility, and the inertial engine test facility. The inertial engine test facility has been abandoned, and no future programs are planned. The remaining facilities support ongoing programs.

- Materials testing and environmental monitoring activities were conducted in the Auxiliary Reactor Area. The facilities in this area are scheduled for D&D.

- The ANL-W facility area consists of several major complexes, including EBR II, Transient Reactor Test Facility, ZPPR, HFEF, FCF, and FMF. The EBR II was being used to demonstrate the Integral Fast Reactor concept. The Transient Reactor Test Facility and the ZPPR are used to conduct reactor

Table 3.4–1. Current Missions at Idaho National Engineering Laboratory

Mission	Description	Sponsor
Argonne National Laboratory-West	Perform breeder reactor irradiation tests Provide storage of Pu material	Office of Nuclear Energy; Assistant Secretary for Environmental Management
Radioactive Waste Management Complex	Provide waste management functions for present and future site and Department needs	Assistant Secretary for Environmental Management
Power Burst Area	Perform waste processing, technology research, and development. Provide interim storage for hazardous wastes	Assistant Secretary for Environmental Management
Test Area North	Perform research on reactor safety operations and conduct a specific manufacturing capability project	Office of Nuclear Energy
Test Reactor Area	Perform irradiation service, develop nuclear instruments, and conduct safety programs. Develop methods to meet radioactive release limits	Office of Nuclear Energy; Office of Naval Reactors
Idaho Chemical Processing Plant	Operations are focused on spent fuel storage and high level waste processing	Assistant Secretary for Environmental Management
Naval Reactors Facility	Standby facility for conducting ship propulsion reactor research and training	Office of Naval Reactors
Central Facilities Area	Provide centralized support services for the site	Idaho Operations Office

Source: INEL 1995a:1.

reactor analysis and safety experiments. The HFEF provides a large inert-atmosphere containment for handling and examining irradiated reactor fuel. The FCF has been modified for the Integral Fast Reactor program to demonstrate remote reprocessing and refabrication in the fuel cycle. The FMF is used to manufacture metallic fuel elements for the fuel cycle and store Pu material.

- Supporting facilities at ANL-W include the Radioactive Liquid Waste Treatment Facility, the Radioactive Scrap and Waste Facility, the Radioactive Sodium Storage Facility, and the Sodium Process Facility. The Radioactive Liquid Waste Treatment Facility processes low-level (aqueous) liquid waste. TRU waste from ANL-W is stored at the Radioactive Scrap and Waste Facility. Contact-handled mixed waste is stored in the Radioactive Sodium Storage Facility (sodium-contaminated), and remote-handled mixed waste is stored at the Radioactive Scrap and Waste Facility. The Sodium Process Facility was built to process reactor sodium.

- The Test Reactor Area (TRA) contains the Advanced Test Reactor. This reactor is used for irradiation testing of reactor fuels and material properties; instrumentation for naval reactors; and production of radioisotopes in support of nuclear medicine, industrial applications, research, and product sterilization. Wastes from this facility are handled by the RWMC.

- The Naval Reactors Facility is operated for DOE and the U.S. Navy by Westinghouse Electric Corporation under jurisdiction of DOE's Pittsburgh Naval Reactors Office. Included at this facility are the submarine prototypes and the expended core facility. Activities include testing of advanced design equipment and new systems for current naval nuclear power propulsion plants and obtaining data for future designs.

- The Central Facilities Area (CFA) provides sitewide support services, including transportation, shop services, health services, radiation monitoring, and administrative offices.

Non-Department of Energy Activities. Non-DOE activities at INEL include research being conducted by NOAA, USGS, and various institutions of higher learning. These activities support the designation of INEL as a National Environmental Research Park (NERP).

3.4.1 LAND RESOURCES

Land Use. The INEL is located within Bingham, Bonneville, Butte, Clark, and Jefferson Counties, 35.4 km (22 mi) west of downtown Idaho Falls in southeastern Idaho. The site covers approximately 230,700 ha (570,000 acres), all of which is owned by the Federal Government and is administered, managed, and controlled by DOE. The Federal Government also owns approximately 75 percent of the land bordering INEL; this land is administered by the BLM. Twenty-four percent of adjacent land is privately owned, with the remaining 1 percent held by the State of Idaho.

Existing Land Use. Generalized land uses at INEL and in the vicinity are shown in Figure 3.4.1–1. About 2 percent of the land within INEL (4,600 ha [11,400 acres]) is used for operating areas and facilities. The developed INEL facilities are situated within a central core area of 91,000 ha (225,000 acres) designated as open space. A buffer zone consisting of 139,600 ha (345,000 acres) surrounding the central core area has been created within INEL boundaries. The BLM has entered into a Memorandum of Understanding with DOE to permit private individuals to graze livestock on the buffer zone rangeland. However, the grazing of livestock is prohibited within the central core area and within 3.2 km (2 mi) of any nuclear facilities. Other agricultural activities consist of approximately 56 ha (138 acres) of irrigated cropland located adjacent to State Routes 28 and 33, and west of the Mud Lake community. No prime farmland lies within the INEL boundaries. In 1975, DOE designated most of INEL as an NERP. It is used by the national scientific community as an outdoor laboratory for research on changes to the natural environment caused by human activities.

Offsite land use within 3.2 km (2 mi) of INEL is shown in Figure 3.4.1–1. This offsite land is primarily used for livestock and agricultural purposes. The closest residence to INEL boundary is 300 m (984 ft) east of the site (approximately 11 km [7 mi] northwest of the unincorporated community of Mud Lake).

Two National Natural Landmarks border INEL: Big Southern Butte (2.4 km [1.5 mi] south) and Hell's Half Acre (2.6 km southeast [1.6 mi]). A portion of Hell's Half Acre National Natural Landmark is designated as a Wilderness Study Area. The Black Canyon Wilderness Study Area is located adjacent to INEL and 15 km (9 mi) west-northwest of TAN. The BLM is considering the Black Canyon Wilderness Study Area for Wilderness Area designation (DOE 1995v:4.5-2). The Cedar Butte Wilderness Study Area is located 4 km (2 mi) south of INEL and 14 km (9 mi) southeast of EBR-I. The BLM does not recommend the Cedar Butte Wilderness Study Area for Wilderness Area designation.

Land-Use Planning. Lands surrounding INEL are subject to Federal and State planning laws and regulations. Land-use planning in Idaho is derived from the *Local Planning Act* of 1975, which requires that each county adopt its own land-use planning and zoning guidelines. County plans applicable to lands bordering INEL include the *Clark County Planning and Zoning Ordinance and Land Use Plan*, the *Bonneville County Comprehensive Plan*, the *Bingham County Zoning Ordinance and Planning Handbook*, the *Jefferson County Comprehensive Plan*, and the *Butte County Comprehensive Plan* (DOE 1995v:4.2–5). Land-use planning for INEL administrative and laboratory facilities located in the city of Idaho Falls is subject to Idaho Falls planning and zoning restrictions. The Idaho Falls zoning ordinance designates these INEL facility areas as I&M-1, Industrial and Manufacturing (IN City 1995a:1).

Visual Resources. The INEL generally consists of open desert land containing sagebrush. The surrounding volcanic cones, domes, and mountain ranges are visible throughout INEL. Much of INEL is the typical open, undeveloped, desert landscape characteristic of the Snake River Plain. The generally low-density character of the INEL facilities have the appearance of commercial/industrial complexes and are dispersed throughout the site. The approximate height of these structures ranges from 3 m (10 ft) to 30 m (100 ft), with a few stacks and towers that reach 76 m (250 ft). Although many INEL facilities are visible from highways, most facilities are located over 0.8 km (0.5 mi) from public roads (DOE 1995v:4.5-1). Industrial use of the developed area within INEL is consistent with a BLM VRM Class 5 designation; other areas range from VRM Class 2 to Class 4.

The Lost River State Rest Area, located along U.S. Route 20/26 (Figure 3.4.1–1), is approximately 5 km (3 mi) southwest of the TRA. Views from the Black Canyon Wilderness Study Area (Figure 3.4.1–1) include agricultural land use and the facilities of INEL. INEL facilities are visible from the Cedar Butte Wilderness Study Area. Views of the facilities from these Wilderness Study Areas are distant and therefore have a minor effect on the overall natural appearance of the area. Craters of the Moon National Monument and Wilderness Area are both approximately 20 km (12.5 mi) southwest from the closest INEL boundary.

3.4.2 SITE INFRASTRUCTURE

Baseline Characteristics. The INEL contains extensive production, service, and research facilities. Not all of these facilities are in operation or are needed today. To support site missions, an extensive infrastructure exists, as shown in Table 3.4.2–1. Pu remaining from various research programs is stored at the ANL-W site in the ZPPR and FMF vaults. The road infrastructure provides intrasite transportation requirements. The railroad infrastructure supports large-volume deliveries of coal and oversized structural components. INEL does not have a connection to local natural gas lines.

Table 3.4.2–1. Idaho National Engineering Laboratory Baseline Characteristics

Characteristics	Current Usage	Site Availability
Transportation		
Roads (km)	445[a]	445[a]
Railroads (km)	48	48
Electrical		
Energy consumption (MWh/yr)	232,500	394,200
Peak load (MWe)	42	124
Fuel		
Natural gas (m^3/yr)	0	0
Oil (l/yr)[b]	5,820,000	16,000,000
Coal (t/yr)	11,340	11,340
Steam (kg/hr)	40,800	40,800

[a] Includes paved and unpaved roads.
[b] Amount includes fuel oil and propane.
Source: DOE 1995j; INEL 1993a:5.

The subregional electrical power pool area in which INEL is located and from which it draws its power is the Northwest Power Pool Area, a part of the Western Systems Coordinating Council. INEL draws its electrical power predominantly from hydroelectric and coal-fired power generating plants. Characteristics of this power pool are given in Table 3.4.2–2.

Table 3.4.2–2. Northwest Sub-Regional Power Pool Electrical Summary

Characteristics	Energy Production
Type Fuel[a]	
Coal	34%
Nuclear	3%
Hydro/geothermal	46%
Oil/gas	7%
Other[b]	11%
Total Annual Production	256,404,000 MWh
Total Annual Load	250,045,000 MWh
Energy Exported Annually	6,359,000 MWh
Generating Capacity	49,596 MWe
Peak Demand	33,325 MWe
Capacity Margin[c]	13,655 MWe

[a] Percentages do not total 100 percent due to rounding.
[b] Includes power from both utility and non utility sources.
[c] Capacity margin is the amount of generating capacity available to provide for scheduled maintenance, emergency outages, system operating requirements, and unforeseen electrical demand.
Source: NERC 1993a.

3.4.3 AIR QUALITY AND NOISE

Meteorology and Climatology. The climate at INEL and in the surrounding region is characteristically that of a semiarid steppe. The average annual temperature at INEL is 5.6 °C (42.0 °F); average monthly temperatures range from a minimum of -8.8 °C (16.1 °F) in January to a maximum of 20.0 °C (68 °F) in July. The average annual precipitation at INEL is 22.1 cm (8.7 in) (IN DOE 1989b:55,77). Prevailing winds at INEL are southwest to west-northwest with a secondary maximum frequency from the north-northeast to northeast. The average annual windspeed is 3.4 m/s (7.5 mph). Additional information related to meteorology and climatology at INEL is presented in Appendix F.

Ambient Air Quality. The INEL is located within the Eastern Idaho Intrastate AQCR (#61). None of the areas within INEL and its surrounding counties are designated as nonattainment areas (40 CFR 81.313) with respect to the NAAQS for criteria pollutants (40 CFR 50). The nearest nonattainment area for particulate matter is in Pocatello, about 80 km (50 mi) to the south. Applicable NAAQS and Idaho State ambient air quality standards are presented in Appendix F.

Three PSD (40 CFR 52.21) Class I areas have been designated in the vicinity of INEL: Craters of the Moon National Monument, Idaho, approximately 53 km (33 mi) west-southwest from the center of the site; Yellowstone National Park, Idaho-Wyoming, approximately 143 km (89 mi) east-northeast from the center of the site; and Grand Teton National Park, Wyoming, approximately 145 km (90 mi) east from the center of the site (IN DOE 1991b:4-11).

Since the creation of the PSD program in 1977, PSD permits were obtained by INEL for two major emission sources: the Coal-Fired Steam-Generating Facility next to the ICPP and the Fuel Processing Restoration Facility, which is not expected to be operated (IN DOE 1980a; IN DOE 1988h).

Historically, the primary emission sources of criteria air pollutants at INEL are the calcination of liquid waste, the combustion of coal for steam generation at the ICPP, and the combustion of fuel oil for heating at various INEL facilities. Other emissions and sources include fugitive particulates from waste-burial activities and coal piles, other processes, vehicles, and temporary emissions from various construction activities. A total of 26 toxic air pollutants have been identified that are emitted from existing INEL facilities in quantities exceeding the screening levels established by the State of Idaho (ID DHW 1995a:103-116; ID DHW 1995b:116-119). Emission estimates for these sources are presented in Appendix F.

Ambient concentration limits for hazardous and toxic air pollutants (to be used by the State as one of the criteria in evaluating construction permit applications for a new emission source) have been adopted by the Idaho Department of Health and Welfare (ID DHW 1995a:103-116; ID DHW 1995b:116-119). The annual emission rates of hazardous and toxic air pollutants from existing INEL facilities during 1990 are listed in Appendix F.

Table 3.4.3–1 presents the baseline ambient air concentrations for criteria pollutants and other pollutants of concern at INEL. As shown in the table, baseline concentrations are in compliance with applicable guidelines and regulations.

Noise. Major noise emission sources within INEL include various industrial facilities, equipment, and machines (for example, cooling systems, transformers, engines, pumps, boilers, steam vents, paging systems, construction and materials handling equipment, and vehicles). Most INEL industrial facilities are at a sufficient distance from the site boundary that noise levels at the boundary from these sources would not be measurable or would be barely distinguishable from background noise levels.

Table 3.4.3–1. Comparison of Baseline Ambient Air Concentrations With Most Stringent Applicable Regulations or Guidelines at Idaho National Engineering Laboratory, 1990

Pollutant	Averaging Time	Most Stringent Regulation or Guideline[a] (μg/m³)	Baseline Concentration (μg/m³)
Criteria Pollutants			
Carbon monoxide	8-hour	10,000[b]	284
	1-hour	40,000[b]	614
Lead	Calendar Quarter	1.5[b]	0.001
Nitrogen dioxide	Annual	100[b]	4
Ozone	1-hour	235[b]	[c]
Particulate matter less than or equal to 10 microns in diameter	Annual	50[b]	5
	24-hour	150[b]	80
Sulfur dioxide	Annual	80[b]	6
	24-hour	365[b]	135
	3-hour	1,300[b]	579
Mandated by the State of Idaho			
Total suspended particulates	Annual	60[d]	5
	24-hour	150[d]	80
Hazardous and Other Toxic Compounds			
Acetaldehyde	Annual	0.45[e]	0.011
Ammonia	Annual	180[e]	6.0
Arsenic	Annual	0.00023[e]	0.00009
Benzene	Annual	0.12[e]	0.029
Butadiene	Annual	0.0036[e]	0.001
Carbon tetrachloride	Annual	0.067[e]	0.0060
Chloroform	Annual	0.043[e]	0.00040
Cyclopentane	Annual	17,000[e]	2.7
Formaldehyde	Annual	0.077[e]	0.012
Hexavalent chromium	Annual	0.000083[e]	0.00006
Hydrazine	Annual	0.00034[e]	0.000001
Hydrochloric acid	Annual	7.5[e]	0.98
Mercury	Annual	1[e]	0.042
Methylene chloride	Annual	0.24[e]	0.006
Naphthalene	Annual	500[e]	18
Nickel	Annual	0.0042[e]	0.0027
Nitric acid	Annual	50[e]	0.64
Perchloroethylene	Annual	2.1[e]	0.11
Phosphorus	Annual	1[e]	0.30
Potassium hydroxide	Annual	20[e]	0.20
Proprionaldehyde	Annual	4.3[e]	0.30
Styrene	Annual	1,000[e]	1.3
Toluene	Annual	3,750[e]	370
Trichloroethylene	Annual	0.077[e]	0.00097

Table 3.4.3–1. Comparison of Baseline Ambient Air Concentrations With Most Stringent Applicable Regulations and Guidelines at Idaho National Engineering Laboratory, 1990—Continued

Pollutant	Averaging Time	Most Stringent Regulation or Guideline[a] ($\mu g/m^3$)	Baseline Concentration ($\mu g/m^3$)
Hazardous and Other Toxic Compounds (continued)			
Trimethylbenzene	Annual	1,230[e]	100
Trivalent chromium	Annual	5[e]	0.036

[a] The more stringent of the Federal and State standard is presented if both exist for the averaging time.

[b] Federal and State standard.

[c] Data not available from source document.

[d] State standard.

[e] Acceptable air concentrations listed in Rules for the Control of Air Pollution in Idaho apply only to new (not existing) sources and are used here as reference levels.

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the site. See Section 4.1.3 for a discussion of ozone-related issues.

Source: 40 CFR 50; DOE 1995v; ID DHW 1995a; ID DHW 1995b.

Existing INEL-related noises of public significance are from the transportation of people and materials to and from the site and in-town facilities via buses, trucks, private vehicles, helicopters, and freight trains. Noise measurements along U.S. Highway 20 about 15 m (50 ft) from the roadway indicate that the sound level from traffic ranges from 64 to 86 dBA (IN DOE 1990b:62), and that the primary source is buses (71 to 80 dBA). While few people reside within 15 m (50 ft) of the roadway, the results indicate that INEL traffic noise might be objectionable to members of the public residing near principal highways or busy bus routes. The acoustic environment along the INEL site boundary in rural areas and at nearby areas away from traffic noise is typical of a rural location, with DNL in the range of 35 to 50 dBA (EPA 1974a:B-4). Except for the prohibition of nuisance noise, neither the State of Idaho nor its local governments have established any regulations that specify acceptable community noise levels.

3.4.4 WATER RESOURCES

Surface Water. Flowing surface water in the INEL area consists of three intermittent streams that drain the adjacent mountains: Big Lost River, Little Lost River, and Birch Creek. The streams usually begin to flow in the spring and are dry by early- to mid-summer. The Big Lost River and Birch Creek are the only surface waters that flow onto the site on a regular basis. The Little Lost River does not enter the site under normal flow conditions. Since much of the flow in these streams is diverted upstream for irrigation, it is possible that several years can pass without any flow entering the INEL boundaries. The USGS is responsible for monitoring the streams, but the only onsite monitoring station is for the Big Lost River. Surface water features near INEL are depicted in Figure 3.4.4–1.

The Big Lost River flows onto the site at the southern part of its western boundary and flows northeastward to the Big Lost River sinks (Playas 1 through 3) (DOE 1992e:4-66). Water flow in the Big Lost River is controlled by the MacKay Dam located approximately 73 km (45 mi) upstream from INEL. Local rainfall and snowmelt are the primary contributors to the surface water flows. Most precipitation is rapidly infiltrated into the soil or evaporated.

Surface water is not used on INEL as a source of drinking water, nor is it used as a receptor for wastewater discharge. Nonradioactive liquid effluents are disposed of primarily to a waste ditch, a lined evaporation pond, an industrial waste pond, five different seepage ponds, and sewage treatment facilities.

Several areas of INEL, such as TAN, TRA, and CFA currently divert stormwater into drainage ditches and discharge flow into soils away from the work area. A large drainage ditch equipped with an automatic sampler surrounds the RWMC to ensure that radionuclides are not transported from the area by stormwater.

Flooding at INEL by the Big Lost River has largely been averted by a flood diversion system constructed in 1958 and upgraded in 1984. The flood diversion system consists of a small dam to direct flow through a diversion channel into four spreading areas (IN DOE 1991b:4-17). The flood diversion system is designed to contain a 300-year flood.

Surface Water Quality. The Big Lost River (from its source to the playas) is designated by the Idaho Department of Health and Welfare's Water Quality Standards and Wastewater Treatment Requirements for the following uses: agricultural and domestic water supply, cold water biota, salmonid spawning, primary and secondary contact recreation, and special resource waters (ID DHW 1992a).

The USGS is responsible for monitoring the surface water quality at INEL. The most recent water samples collected within the facility boundaries were collected from the Big Lost River below the diversion dam in June 1995, when the river flowed for several weeks. The results of the analysis and the Idaho Water Quality Standards for the Protection of Domestic Water Supplies are presented in Table 3.4.4–1. The analytical results indicate that there are no parameters in exceedance of the water quality criteria.

Surface Water Rights and Permits. Surface water rights are not an issue at INEL because INEL facilities do not withdraw surface water for use nor do they discharge effluents directly to natural surface waters.

Groundwater. The Snake River Plain Aquifer, classified by EPA as a Class I sole source aquifer, is located beneath the entire INEL site and covers a total area of approximately 24,860 km^2 (9,600 mi^2) in southeastern Idaho. The aquifer serves as a primary source for drinking water and crop irrigation in the Snake River Basin (IN DOE 1995f:99). It is composed of 610 to 3,048 m (2,000 to 10,000 ft) of lava flows, rhyolite, and interbedded sediments and is believed to contain 1,200 to 2,500 trillion l (317 to 660 trillion gal) of water.

Water from Henry's Fork of the Snake River infiltrates the subsurface and supplies a significant amount of water to the Snake River Plain Aquifer below INEL. Additional recharge to the aquifer comes from the Big Lost River, Little Lost River, and Birch Creek, which originates in the mountains to the northwest of INEL, flows onto the site during a few months of the year, and sinks into its porous soils. Precipitation and snowmelt also contribute to its recharge. Local groundwater movement is complicated, but overall, groundwater flows laterally at an average rate of 1.5 to 6.1 m (4.9 to 20 ft) per day to the south and southwest, as shown in Figure 3.4.4–2. The groundwater emerges in springs (about 8 trillion l [2.1 trillion gal] annually) along the Snake River from Milner (located to the west of Burley) to Bliss, Idaho, and from Blackfoot to American Falls Reservoir in the region west of Pocatello, Idaho (IN DOE 1995f:3). Depth to the water table ranges from 60 m (200 ft) below the ground surface in the northeast corner of INEL to 300 m (1,000 ft) in the southeast corner (DOE 1992e:4-69).

Table 3.4.4–1. Summary of Big Lost River Surface Water Quality Monitoring at Idaho National Engineering Laboratory, 1995

Parameter	Unit of Measure	Water Quality Criteria[a]	Maximum Water Body Concentration
Arsenic	mg/l	0.05[b]	.0002
Barium	mg/l	1.0[c]	<0.0085
Cadmium	mg/l	0.005[b]	<0.001
Chromium	mg/l	0.05[c]	0.0042
Lead	mg/l	0.015[b]	<0.001
Mercury	mg/l	0.002[b,c]	<0.0001
pH	pH units	6.5-8.5[c]	8.4
Selenium	mg/l	0.01[b,c]	0.001
Silver	mg/l	0.05[b,c]	<0.001
Temperature	°C	22[c]	15

[a] For comparison purposes only.
[b] National Primary Drinking Water Regulation (40 CFR 141).
[c] State of Idaho Water Quality Criteria.
Source: ID DHW 1992a; IN USGS 1995a.

Perched water tables occur in the INEL area. The presence of these perched water bodies is believed to be beneficial to water quality in the Snake River Plain Aquifer. These perched water bodies slow waste migration, allow for radioactive decay, and spread any waste plumes over a wider area for greater dilution (DOE 1992e:4-70).

Groundwater Quality. There are several "networks" of monitoring wells drilled and maintained by USGS. These include the INEL-wide facility groundwater monitoring group and well networks for RCRA- and CERCLA-required monitoring. Groundwater beneath INEL is monitored by groups including USGS, DOE's site contractor, LITCO, other DOE contractors, and the State of Idaho. USGS has drilled more than 120 wells in the Snake River Plain Aquifer and 100 in the perched zone on and near INEL. Water supply wells, monitoring wells, and offsite water supply wells are routinely sampled for chemical and radiological constituents (DOE 1992e:4-70).

Historically, there has been radionuclide contamination of the Snake River Plain Aquifer. Between 1952 and 1988, approximately 30,900 Ci of tritium were disposed of into wells and infiltration ponds at INEL (mainly from the ICPP, TRA, and also the TAN). No tritium is currently disposed of to the groundwater at INEL, but large tritium plumes are present in the Snake River Plain Aquifer and in perched groundwater under the ICPP and TRA (Figure 3.4.4–2) (IN USGS 1988a:7). Tritium occurs at elevated levels in some monitoring wells and has been detected in groundwater near the southern boundary of INEL, 14.5 km (9 mi) south of the ICPP and TRA. The average concentration of tritium in water from six INEL production wells has remained constant since 1990 (IN DOE 1995f:72). In 1994, the highest tritium concentrations occurring in INEL drinking water were in the area of the CFA; the concentration ranged from 12,600 to 18,000 pCi/l (47,697 to 68,138 pCi/gal) (IN DOE

1995f:71). The elimination of tritium disposal, coupled with its radioactive decay, and dilution and dispersion within the groundwater reservoir are factors contributing to a 93-percent decrease in tritium concentration levels from 1961 to 1994.

Other radionuclides of significance include Cs-137, I-129 and Sr-90. Cs-137 is strongly adsorbed on mineral grains in the soils, so it is unlikely that it will reach the aquifer in significant amounts. As shown in Figure 3.4.4–2, plumes have been delineated for Sr and I.

Groundwater contamination from the injection well at TAN is being remediated as specified in a 1994 ROD and subsequent Fact Sheet. Another 1994 ROD addresses groundwater contamination at RWMC. Buried drums in this area released VOCs (for example, trichloroethylene) that have migrated downward to the Snake River Plain Aquifer. However, concentrations of these compounds were found to be below drinking water standards (IN DOE 1995f:32).

Samples from 32 offsite USGS wells beyond the southern and western site boundaries were taken in 1994. All gross alpha concentrations were within the expected concentration range for naturally occurring alpha activity in the aquifer underlying the INEL and surrounding areas. According to USGS reports, alpha-emitting wastes from site operations have not migrated far from their entrance into the aquifer near ICPP (IN DOE 1995f:69). None of the offsite water samples collected during 1994 contained detectable concentrations of tritium or gross beta activity radionuclides.

Nonradioactive wastes, including sodium chloride, sulfuric acid, sodium hydroxide, and organics, have also been discharged to ponds within many of the operating areas. In the past, wastewater has also been injected into deep disposal wells at the TRA and ICPP. The TDS concentrations of the injected wastewaters were approximately twice those present in the natural groundwater (IN USGS 1988a:20). There are no plans to use injection wells for future wastewater disposal. Monitoring of the Snake River Plain Aquifer for nonradiological constituents, including sodium chloride, total chromium, trace metals, and nitrates, showed concentrations for these contaminants to be at or below background levels at least 4 km (2.5 mi) inside the nearest site boundary (IN DOE 1994c:54).

Only nonradioactive and nonhazardous liquid wastes are currently discharged into the sanitary and service waste disposal systems. All hazardous and radioactive wastes are stored or disposed of in approved facilities designed to preclude further groundwater contamination. Groundwater quality data is shown in Table 3.4.4–2.

Groundwater Availability, Use, and Rights. The Snake River Plain Aquifer is the source of all water used at INEL. The combined pump capacity of the 27 onsite production wells averaged approximately 7.9 billion l/yr (2.1 billion gal/yr) from 1982 through 1985. This is 0.3 percent of the 2.44 trillion l/yr (645 billion gal/yr) of groundwater withdrawn from the aquifer in the Eastern Snake River Plain. Most of the water withdrawn from the aquifer in the Eastern Snake River Plain (2.34 trillion l/yr [619 billion gal/yr]) is used for agriculture. After use and treatment, approximately 63 percent of the quantity of groundwater withdrawn at INEL is disposed of in wells and ponds (DOE 1992e:4-73).

In the INEL ROI, Idaho Falls, Pocatello, and Rigby maintain water supply systems. All of the community drinking water systems draw their raw water from the Snake River Plain Aquifer. In 1991, the combined water supply capacity for these systems was approximately 538 million l/day (142.1 million gal/day). The combined demand averaged about 204 million l/day (53.9 million gal/day), or 38 percent of capacity.

The Department holds a Federal Reserved Water Right for the INEL site, which permits a water pumping capacity of 2.3 m^3/s (80 ft^3/s) and a maximum water consumption of 43 billion l/yr (11.4 billion gal/yr) for drinking, process water, and noncontact cooling (DOE 1992e:4-74). Because it is a Federal Reserved Water Right, INEL's priority on water rights dates back to its establishment in 1950. The legal and administrative framework for the water rights adjudication process is currently being evaluated for the State of Idaho.

Table 3.4.4–2. Groundwater Quality Monitoring at Idaho National Engineering Laboratory, 1994

Parameter	Unit of Measure	Water Quality Criteria and Standards[a]	Drinking Water and Production Wells High	Drinking Water and Production Wells Low
1-Dichlorobenzene	mg/l	0.075[b]	0.0007	0.0007
1,1,1-Trichloroethane	mg/l	0.2[b]	0.0028	<dL
Alpha (gross)	pCi/l	15[b]	2.8	<dL
Barium	mg/l	1.0[c]	0.09	0.003
Beta (gross)	pCi/l	50[d]	8.0	<dL
[Text deleted.]				
Carbon tetrachloride	mg/l	0.005[b]	0.0006	<dL
Chloroform	mg/l	0.1[b]	0.0047	<dL
Chromium	mg/l	0.05[b]	0.007	0.003
Strontium-90	pCi/l	400[e]	0.8	<dL
Tetrachloroethylene	mg/l	0.005[b]	0.0047	<dL
Trichloroethylene	mg/l	0.005[b]	0.0166	<dL
Tritium	pCi/l	80,000[e]	18,000	1,300

[a] For comparison purposes only.
[b] National Primary Drinking Water Regulations (40 CFR 141).
[c] State water quality criteria.
[d] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).
[e] DOE's DCG for water (DOE Order 5400.5). DCG values are based on a committed effective dose equivalent of 100 mrem per year; however, because the drinking water maximum contaminant level is based on 4 mrem per year, the number listed is 4 percent of the DCG.

Note: dL=detection limit.
Source: IN DOE 1995f.

3.4.5 GEOLOGY AND SOILS

Geology. The INEL occupies a relatively flat area on the northwestern portion of the Eastern Snake River Plain. The INEL area consists of a broad plain that has been built up from the eruptions of multiple flows of basaltic lava. INEL is bordered by Centennial Range Mountains on the north and the overthrust belt on the east. The Eastern Snake River Plain consists of Miocene and younger volcanic rocks that probably rest upon older sedimentary and plutonic rocks, as well as faulted remains of Eocene volcanic rocks. Within INEL, economically viable sand, gravel, and pumice resources have been identified. Several quarries have supplied these materials to various onsite construction projects.

The oldest faults in the region occur both to the north and south of INEL and are approximately 40 to 65 million years old. The Arco Segment of the Lost River Fault and the Howe Segment of the Lemhi Fault are range-front normal faults associated with the Basin and Range Province and have been active during recent geologic time (100,000 to 15,000 years ago); they are considered to be the closest capable faults to INEL by the definition outlined in 10 CFR 100, Appendix A. These faults terminate approximately 30 km (19 mi) from the INEL boundary (Figure 3.4.5–1).

The INEL is located in Seismic Zone 2B. For this PEIS, Uniform Building Code Seismic Zones 2A and 2B are included in Seismic Zone 2 (Figure 3.2.5–1), indicating that moderate damage could occur as a result of an earthquake. Seismic Zone 3 is located in adjacent regions to the north, east, and south of INEL.

The INEL is situated on the Eastern Snake River Plain, an area of low seismicity. The Plain is bordered by the seismically active Centennial Tectonic Belt to the north and the Intermountain Seismic Belt to the east and southeast. Historical and recent seismic data cataloged by NOAA, the National Earthquake Information Center (NEIC), the University of Utah, and the INEL Seismic Network indicates that earthquakes in the region occur primarily in the Intermountain Seismic Belt and Centennial Tectonic Belt (including the mountains and valleys of the Basin and Range province which bound the Plain on the north and south) (IN DOE 1991b:4-28). The seismic characteristics of the Plain and the adjacent Basin and Range province are different; earthquakes and active faulting are associated with the Basin and Range tectonic activity, whereas the Plain has historically experienced few and small earthquakes (DOE 1995j:4.6-1).

[Text deleted.] Historically there have been several earthquakes in the region surrounding INEL (Figure 3.4.5–1). However, none of these occurred within approximately 48 km (30 mi) of the site. The largest historic earthquake near INEL took place in 1983, approximately 107 km (66 mi) to the northwest, near Borah Peak in the Lost River Range. The earthquake had a Richter magnitude of 7.3 with a resulting peak ground acceleration of 0.022 to 0.078 g at INEL (DOE 1995j:4.6-1). An earthquake of greater than 5.5 magnitude can be expected approximately every 10 years within a 321-km (200-mi) radius of INEL.

The only recorded earthquake on the Eastern Snake River Plain with a Richter magnitude greater than 5.5 was the 1905 event that had a magnitude of 5.7. Recent interpretations of the event, however, have suggested that its epicenter was more likely to have been in Utah or Nevada. The distribution of earthquakes at and near INEL from 1884 to 1989 (Figure 3.4.5–1) clearly shows that the Eastern Snake River Plain has a low rate of seismicity.

Volcanic hazards at INEL can come from sources inside or outside the Snake River Plain. Volcanic hazards include the effects of lava flows, ground deformation (fissures, uplift, subsidence), volcanic earthquakes (associated with magmatic processes as distinct from earthquakes associated with tectonics), and ash flows or airborne ash deposits. Most of the basaltic volcanic activity occurred from 4 million to 2,100 years ago at the Craters of the Moon National Monument 20 km (12.5 mi) southwest of INEL. The rhyolite domes along the Axial Volcanic Zone formed between 1.2 and 0.3 million years ago and have a recurrence interval of about 200,000 years. Therefore, the probability of future dome formation affecting INEL site facilities is very low (DOE 1995j:4.6-9).

Catastrophic Yellowstone type volcanic eruptions have occurred three times in the past 2 million years, but the INEL site lies more than 160 km (99 mi) southwest from the Yellowstone Caldera rim, and high-altitude winds would not disperse Yellowstone ash in the direction of INEL. Additionally, the infrequency, distance, and unfavorable dispersal of pyroclastic flows or ash fallout from future Yellowstone eruptions are not expected to affect the INEL site (DOE 1995j:4.6-9).

Basaltic lava flows and eruptions from fissures or vents have been considered in this PEIS. Based on a probability analysis of the volcanic history in and near the southcentral INEL area, the Volcanism Working Group estimated that the conditional probability that basaltic volcanism would affect a south-central INEL site location is less than 2.5×10^{-5} per year (once per 40,000 years or longer), where the hazard associated with Axial Volcanic Zone volcanism is greatest. The probability of a volcanic event affecting INEL site facilities farther north, where both silicic and basaltic volcanism have been older and less frequent, is estimated to be less than 1.0×10^{-6} per year (once every million years or longer). The statistics of 116 measured INEL-area lava flow lengths and areas were used to define the two lava flow hazard zones (Figure 3.4.5–2). The mean lava flow length plus one standard deviation from the mean corresponds to 14 km (8.7 mi). The hazard for a particular site within or near a volcanic zone is much lower, typically by an order of magnitude or more, and must be assessed on a site-specific basis (DOE 1995j:4.6-9).

Soils. The INEL soils are derived from volcanic and clastic rocks from nearby highlands (IN DOE 1986a:4). In the southern part of INEL, the soils are gravelly to rocky and generally shallow. The northern portion is composed mostly of unconsolidated clay, silt, and sand. Generally, the soils are acceptable for standard construction techniques and consist of wind-blown sand and silt lying in patches over a bedrock of basaltic lava. These soils have a low-to-moderate water erosion hazard and a moderate-to-high wind erodibility. Shrink-swell potential is generally low to moderate.

3.4.6 BIOLOGICAL RESOURCES

Terrestrial Resources. The INEL lies in a cool desert ecosystem dominated by shrub-steppe communities. Most land within the site is relatively undisturbed and provides important habitat for species native to the region. Facilities and operating areas occupy 2 percent of INEL; approximately 60 percent of the area around the periphery of the site is grazed by sheep and cattle (DOE 1992e:4-76). Although sagebrush communities occupy about 80 percent of INEL, a total of 20 plant communities have been identified (IN DOE 1986a:4) (Figure 3.4.6–1). The interspersion of low and big sagebrush communities in the northern portion of INEL, and the juniper communities located in the northwestern and southeastern portions of the site are considered sensitive habitats (IN DOE 1986a:4,8). The former provides critical winter and spring range for sage grouse and pronghorn, while the latter is important to nesting raptors and songbirds. Riparian vegetation, primarily cottonwood and willow, along the Big Lost River and Birch Creek also provides nesting habitat for hawks, owls, and songbirds (DOE 1992e:4-76). In total, 398 plant taxa have been documented on INEL (IN DOE 1978a:129-131).

The INEL supports numerous animal species, including 1 amphibian, 9 reptile, 184 bird, and 37 mammal species (DOE 1992e:4-76). Common animals on INEL include the short-horned lizard, gopher snake, sage sparrow, Townsend's ground squirrel, and black-tailed jackrabbit. Important game animals include the sage grouse, mule deer, elk, and pronghorn. During some winters, 4,500 to 6,000 pronghorn, or about 30 percent of Idaho's total population, may be found on INEL. Pronghorn wintering areas are located in the northeastern portion of the site, in the area of the Big Lost River sinks, in the west-central portion of the site along the Big Lost River, and in the south-central portion of the site (IN DOE 1978a:221-222). Hunting is permitted only within about 1 km (0.6 mi) of the northern site boundary. Pronghorn, which is the only species taken, are hunted in order to control damage to agricultural land (INEL 1992a:2). Numerous raptors, such as the golden eagle and prairie falcon, and carnivores, such as the coyote and mountain lion, are also found on INEL. A variety of migratory birds has been found at INEL. Migratory birds, as well as their nests and eggs, are protected by the *Migratory Bird Treaty Act*. Eagles are similarly protected by the *Bald and Golden Eagle Protection Act*.

Within the proposed site for the storage facility (which is also the assumed analysis site for the evolutionary LWR), shallow soils (which occupy most of the area) are dominated by big sagebrush (Figure 3.4.6–1). In low-lying areas of deep soil, the dominant vegetation is perennial grasses. Isolated stands of juniper also exist in the area. Cheatgrass, an aggressive European annual that readily replaces native species in disturbed areas, is also present. Elk use areas in the vicinity of the site during the fall, winter, and spring, but pronghorn use is relatively low. Pronghorn wintering areas are located no closer than about 6.5 km (4 mi) from the site area. Sage grouse are known to use the site but not for breeding. The isolated stands of juniper in the area provide potential nesting habitat for hawks and owls (DOE 1992e:4-76).

Wetlands. The NWI maps prepared by the USFWS have been completed for most of INEL. The NWI maps indicate that the primary wetland areas are associated with the Big Lost River, the Big Lost River spreading areas, and the Big Lost River sinks, although smaller (less than about 0.4 ha [1 acre]) isolated wetlands also occur. Wetlands associated with the Big Lost River are classified as riverine/intermittent, indicating a defined stream channel with flowing water during only part of the year.

The Big Lost River spreading areas and Big Lost River sinks are seasonal wetlands and are located approximately 15 km (9.3 mi) southwest and 24 km (14.9 mi) north of the proposed new consolidated Pu storage facility site (and analysis site for the evolutionary LWR), respectively (Figure 2.3–3). These areas can provide more than 809 ha (2,000 acres) of wetland habitat during wet years. Riparian wetland vegetation exists along the Big Lost River and along Birch Creek. Plants found along the Big Lost River, which is located about 2.5 km (1.6 mi) west of the proposed site, are in poor condition due to recent years of only intermittent flows.

Aquatic Resources. Aquatic habitat on INEL is limited to the Big Lost River, Little Lost River, Birch Creek, and a number of liquid-waste disposal ponds (see Figure 3.4.4–1). All three streams are intermittent and drain into four sinks in the north-central part of INEL. Historically, six species of fish have been observed in the Big Lost River: brook trout, rainbow trout, mountain whitefish, speckled dace, shorthead sculpin, and kokanee salmon (DOE 1992e:4-78; DOE 1992h:G-11).

The Little Lost River, located west of INEL, and Birch Creek, located north of the proposed new consolidated Pu storage facility site (and assumed analysis site for the evolutionary LWR), enter INEL only during periods of high flow (IN EG&G nda:22). Surveys of fish in these surface water bodies have not been conducted. The liquid waste disposal ponds on INEL, while considered aquatic habitat, do not support fish (INEL 1992a:4). No aquatic habitat occurs on the proposed site, which is located about 2.5 km (1.6 mi) east of the Big Lost River.

Threatened and Endangered Species. Nineteen federally and State-listed threatened, endangered, and other special status species may be found on and in the vicinity of INEL. Two of these species are federally and State-listed as threatened or endangered (Table 3.4.6–1). Twelve species listed in Table 3.4.6–1 have been observed at INEL, including the two threatened and endangered species. Once specific project locations have been determined, site surveys will determine the presence of special status species. No critical habitat for threatened or endangered species, as defined in the ESA (50 CFR 17.11; 50 CFR 17.12), exists on INEL (DOE 1992e:4-78).

The bald eagle has rarely been seen in the western and northern portions of INEL. The peregrine falcon has only occasionally been observed in the northern portions of the site. [Text deleted.]

Several of the species listed in Table 3.4.6–1 may occur in the vicinity of the proposed storage site (and assumed location for the evolutionary LWR). The pygmy rabbit is common at INEL, but its distribution is patchy (DOE 1995j:4.9-4). The Townsend's western big-eared bat (which roosts in caves at INEL) and the other bat species have not been observed in the area of the proposed site but could potentially occur. [Text deleted.]

The State of Idaho does not maintain a list of threatened or endangered plant species. Plants that are considered rare in Idaho are included in a State Watch List. The tree-like oxytheca, listed by the State as a sensitive species, has been found in the area of the proposed site (DOE 1992e:4-79).

Table 3.4.6–1. Federally and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found on or in the Vicinity of Idaho National Engineering Laboratory

Common Name	Scientific Name	Status[a] Federal	Status[a] State
Mammals			
Fringed myotis	*Myotis thysanodes*	NL	SSC
[Text deleted.]			
Pygmy rabbit[b]	*Brachylagus idahoensis*	NL	SSC
[Text deleted.]			
Spotted bat	*Euderma maculatum*	NL	SSC
Townsend's western big-eared bat[b]	*Plecotus townsendii townsendii*	NL	SSC
Western pipistrelle	*Pipistrellus hesperus*	NL	SSC
[Text deleted.]			
Birds			
American white pelican	*Pelecanus erythrorhynchos*	NL	SSC
Bald eagle[b,c]	*Haliaeetus leucocephalus*	T	E
Common loon	*Gavia immer*	NL	SSC
[Text deleted.]			
Great egret	*Casmerodius albus*	NL	SSC
Northern goshawk	*Accipiter gentilis*	NL	SSC
Peregrine falcon[b,c]	*Falco peregrinus*	E (S/A)	E
[Text deleted.]			
Plants[d]			
King's bladderpod[b]	*Lesquerella kingii var. cobrensis*	NL	M
Lemhi milkvetch[b]	*Astragalus aquilonius*	NL	S
Nipple cactus[b]	*Coryphantha missouriensis*	NL	M
Painted milkvetch[b]	*Astragalus ceramicus var. apus*	NL	M
Plains milkvetch[b]	*Astragalus gilviflorus*	NL	SP1
Spreading gilia[b]	*Ipomopsis polycladon*	NL	SP2
Tree-like oxytheca[b]	*Oxytheca dendroidea*	NL	S
Winged-seed evening primrose[b]	*Camissonia pterosperma*	NL	S

[a] Status codes: E=endangered; M=monitor; NL=not listed; S=sensitive; S/A=protected under the similarity of appearance provision of the ESA; SP1=State Priority 1 (in danger of becoming extinct in the state); SP2=State Priority 2 (likely to be classified as Priority 1 if factors contributing to decline remain unchanged); SSC=State special concern.

[b] Species observed on INEL.

[c] USFWS Recovery Plan exists for this species.

[d] State status of plant species is designated by the Idaho Native Plant Society.

Source: 50 CFR 17.11; 50 CFR 17.12; DOE 1992e; DOE 1995j; ID DFG 1994a; IN DOE 1984a.

3.4.7 CULTURAL AND PALEONTOLOGICAL RESOURCES

Prehistoric Resources. Prehistoric resources identified on INEL include residential bases, campsites, rock shelters, hunting blinds, rock alignments, lithic quarries, and limited activity locations, including lithic and ceramic scatters, hearths, and concentrations of fire-affected rock. As of 1994, over 100 cultural resources surveys had been conducted, and approximately 4 percent of INEL had been inventoried for cultural resources (DOE 1995v:4.4-1). Resources include 688 prehistoric sites and 753 prehistoric isolates. Of the prehistoric sites that have been recorded, approximately 95 percent are lithic scatters or locations. Most sites have not yet been formally evaluated and are considered potentially eligible for the NRHP. Additional NRHP-eligible sites are likely to occur on INEL. A Draft Cultural Resources Management Plan has been prepared and is currently in the comment stage.

Historic Resources. Thirty-eight historic sites and 27 historic isolates have been identified on INEL; most are related to either agriculture (for example, homesteads and irrigation canals) or ranching (for example, sheep and cattle camps). Goodale's Cutoff, a spur of the Oregon Trail, is still recognizable in the southwestern corner of INEL. Experimental Breeder Reactor I, the first reactor to achieve a self-sustaining chain reaction using Pu instead of uranium as the principal fuel component, is listed on the NRHP and is designated a National Historic Landmark. Various other nuclear reactors and associated buildings, such as those at Auxiliary Reactor Area-I, -II, -III, the Borax Reactor, Materials Test Reactor, Engineering Test Reactor, and the Hot Shop, are considered eligible for the NRHP. Although such facilities are not yet 50 years old, they are of exceptional scientific and engineering significance and have played major roles in the development of nuclear science since World War II. Based on current studies, additional historic sites are likely to occur in unsurveyed portions of INEL.

Native American Resources. At the time of European-American contact, the area was inhabited by nomadic hunters and gatherers consisting of two linguistically distinct groups: the Shoshone and the Bannock. Horses enabled the Shoshone and Bannock to increase their foraging range, congregate in larger groups, and protect their possessions from other groups. Winter camps were reportedly scattered along major river drainages. Groups dispersed during the other seasons, probably moving across what is now INEL as they used floral and faunal resources, and obsidian from Big Southern Butte or Howe Point.

Important Native American resources that might be found in the proposed project area include buttes, caves, village shrines, rock art, burials, vision quest sites, and plants such as bluegrass, willow, and cattail. It is worth noting that many natural resources at INEL are viewed as cultural resources by Native Americans. As one example, sagebrush is used as a tool, for clothing, and for medicinal purposes. INEL recently initiated general consultation with the Shoshone-Bannock tribe and a Working Agreement between the two groups exists. While specific sites or traditional use areas have not yet been identified, the Shoshone and Bannock tribes consider INEL part of their ancestral homeland and have expressed support for the use of scientific methods to preserve cultural resources.

Paleontological Resources. The Snake River Plain is composed of numerous superimposed basalt lava flows that came from low-shield volcanoes, fissures, and tubes during the last two billion years. Except for a small area of Paleozoic deposits in the northwest corner of INEL, almost 75 percent of the facility is basalt flows covered with loess. The remainder of INEL (primarily in the north and northwest portions of the facility) is alluvial and aeolian sediments; fluvial sediments are found along the drainages.

As of 1994, 31 fossil localities have been identified at INEL. Fluvial sediments have yielded Late Pleistocene terrestrial vertebrate fossils, including mammoth, mastodon, horse, camel, and bison. Gastropods, microfauna, plant fossils, opal phytoliths, and pollen have also been recovered. Volcanic tubes and blisters serve as sediment traps and many in the older basalt flows contain fossils of small and medium-sized mammals. While most of these fossils date to the Holocene (within the last 10,000 years), some date to the Pleistocene-Holocene transition of about 11,500 years ago. Because these assemblages may contain both vertebrate and floral remains, such localities would have high research potential.

3.4.8 SOCIOECONOMICS

Socioeconomic characteristics described for INEL include employment and regional economy, population and housing, community services, and local transportation. Statistics for employment and regional economy are presented for the REA that encompasses 13 counties around INEL located in Idaho and Wyoming (Table L.1–1). Statistics for population and housing, community services, and local transportation are presented for the ROI, a five-county area (located in Idaho) in which 97.2 percent of all INEL employees reside: Bannock County (5.6 percent), Bingham County (12.6 percent), Bonneville County (69.2 percent), Butte County (2.5 percent), and Jefferson County (7.3 percent). [Text deleted.] In 1996, INEL employed 6,547 persons (IN DOE 1996b:1) (This total does not include some contractor employees.)

Regional Economy Characteristics. Selected employment and regional economy statistics for the INEL REA are summarized in Figure 3.4.8–1. Between 1980 and 1990, the civilian labor force in the REA increased 10.4 percent to the 1990 level of 119,700. The 1994 unemployment in the REA was 5.4 percent, which was about the same as the unemployment for Idaho (5.6 percent) and Wyoming (5.3 percent). The region's per capita income of $16,674 in 1993 was approximately 5 percent less than Idaho's per capita income of $17,511 and 15.4 percent less than Wyoming's per capita income of $19,719.

In 1993, the percentage of total employment involving the private sector activity of retail trade was similar in the REA (18 percent), Idaho, and Wyoming as shown in Figure 3.4.8–1. Service activities in the REA (27 percent of total employment) represented about a 4- and 4.5-percent greater share than in Idaho and Wyoming, respectively. Manufacturing in the REA (9 percent) represented a 3-percent smaller share of total employment than in Idaho and a 6-percent larger share than in Wyoming.

Population and Housing. In 1994, the ROI population totaled 212,610. Between 1980 and 1994, the ROI population grew by 14.0 percent, compared to 20.0 percent in Idaho. Within the ROI, Jefferson County experienced the largest increase at 20.4 percent, while Butte County's population decreased by 8.9 percent. Population and housing trends are summarized in Figure 3.4.8–2.

The increase in the total number of housing units in the ROI between 1980 and 1990, 6.5 percent, was approximately 3.5 percent less than the increase in the number of housing units in Idaho. The total number of housing units in the ROI for 1990 was 71,025. The 1990 ROI homeowner and renter vacancy rates, 2.2 and 8.5 percent, respectively, were similar to those in Idaho.

Community Services. Education, public safety, and health care characteristics were used to assess the level of community services in the INEL ROI. Figure 3.4.8–3 presents school district characteristics for the INEL ROI. Figure 3.4.8–4 presents public safety and health care characteristics.

Education. In 1994, 14 school districts provided public education services and facilities in the INEL ROI. As shown in Figure 3.4.8–3, these school districts operated at between 38-percent (Swan Valley School District) and 101.2-percent (Firth School District) capacity. The average student-to-teacher ratio for the INEL ROI in 1994 was 18.5:1. The Shelley School District had the highest ratio at 22.2:1.

Public Safety. City, county, and State law enforcement agencies provided police protection to the residents in the ROI. In 1994, a total of 340 sworn police officers were serving the five-county ROI. Idaho Falls employed the largest number of officers (82) and Bannock County had the highest officer-to-population ratio (2.5 sworn officers per 1,000 persons). The average ROI officer-to-population ratio was 1.6 officers per 1,000 persons. Figure 3.4.8–4 compares police force strengths across the ROI.

Fire protection services in the INEL ROI were provided by 465 paid and volunteer firefighters in 1995. The district with the highest firefighter-to-population ratio was located in Butte County, with 7.5 firefighters per 1,000 persons, as indicated in Figure 3.4.8–4. Jefferson County employed the greatest number of firefighters (90). The average firefighter-to-population ratio in the ROI was 2.2 per 1,000 persons.

Health Care. There were five hospitals serving the five-county ROI in 1994. Figure 3.4.8–4 displays the hospital bed-to-population ratios for the INEL ROI counties. During 1994, all hospitals were operating at below capacity, with hospital occupancy rates ranging from 48.0 percent in Bannock County to 60.8 percent in Bingham County.

In 1994, a total of 264 physicians served the ROI, with the majority (129) located in Bonneville County. Figure 3.4.8–4 shows that the physician-to-population ratios for the ROI ranged from no physicians in Butte County to 1.6 physicians per 1,000 persons in Bonneville County and Bannock County. The average ROI physician-to-population ratio was 1.2 physicians per 1,000 persons.

Local Transportation. Vehicular access to INEL is provided by U.S. Routes 20 and 26 to the south and State Routes 22 and 33 to the north. U.S. Routes 20 and 26 and State Routes 22 and 33 all share rights-of-way west of INEL (see Figure 2.2.3–1 and Figure 2.2.3–2).

There is one current road improvement project affecting access to INEL. U.S. Route 20 is being upgraded from two to four lanes and turn lanes are being added at intersections from 2 to 5 km (1 to 3 mi) west of Idaho Falls. In addition, there are four planned road improvement projects that could affect future access to INEL. The first is an upgrade from two to four lanes and the addition of turn lanes at intersections from 5 to 8 km (3 to 5 mi) west of Idaho Falls. The second is the resurfacing of State Route 33 from the intersection of State Routes 28 and 33 to 13 km (8 mi) east of this intersection. The third is the resurfacing of Interstate 15 from Fort Hall to South Blackfoot. The last is the asphalt chip seal of U.S. Route 26 from the U.S. Route 20 and U.S. Route 26 intersection to Blackfoot (ID DOT 1995a:1).

There are two road segments that could be affected by the storage and disposition alternatives. The first road segment is U.S. Route 20 from U.S. Routes 26 and 91 at Idaho Falls to U.S. Route 26 East. In 1995 this road segment operated at level of service D. The second road segment is U.S. Routes 20 and 26 from U.S. Route 26 East to State Routes 22 and 33. This segment operated at level of service B in 1995.

The Department shuttle vans provide transportation between INEL facilities and Idaho falls for the 4,000 DOE and contractor personnel who work at INEL. The major railroad in the ROI is the Union Pacific Railroad. The railroad's Blackfoot-to-Arco branch provides rail service to the southern portion of INEL. A DOE-owned spur connects the Union Pacific Railroad to INEL by a junction at Scovill Siding. There are no navigable waterways within the ROI capable of accommodating waterborne transportation of material shipments to INEL.

Fanning Field in Idaho Falls and Pocatello Municipal Airport in Pocatello provide jet air passenger and cargo service for both national and local carriers. Numerous smaller private airports are located throughout the ROI.

3.4.9 PUBLIC AND OCCUPATIONAL HEALTH AND SAFETY

Radiation Environment. Major sources and levels of background radiation exposure to individuals in the vicinity of INEL are shown in Table 3.4.9–1. Annual background radiation doses to individuals are expected to remain constant over time. The total dose to the population changes as the population size changes. Background radiation doses are unrelated to INEL operations.

Table 3.4.9–1. Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Idaho National Engineering Laboratory Operation

Sources	Effective Dose Equivalent (mrem/yr)
Natural Background Radiation[a]	
Cosmic radiation	39
External terrestrial radiation	59
Internal terrestrial	40
Radon in homes (inhaled)	200
Other Background Radiation[b]	
Diagnostic x rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	403

[a] IN DOE 1994c.
[b] NCRP 1987a.
Note: Value for radon is an average for the United States.

Releases of radionuclides to the environment from INEL operations provide another source of radiation exposure to individuals in the vicinity of INEL. Types and quantities of radionuclides released from INEL operations in 1993 are listed in *The Idaho National Engineering Laboratory Site Environmental Report for Calendar Year 1993* (DOE/ID-12082 [93]). The doses to the public resulting from these releases are presented in Table 3.4.9–2. These doses fall within radiological limits (DOE Order 5400.5) and are small in comparison to background radiation. The releases listed in the 1993 report were used in the development of the reference environment's (No Action) radiological releases and resulting impacts at INEL in the year 2005 (Section 4.2.3.9).

Based on a risk estimator of 500 cancer deaths per 1 million person-roentgen equivalent man (rem) to the public (Section M.2.1.2), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from INEL operations in 1993 is estimated to be 1.5×10^{-8}. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of INEL operations is about 2 chances in 100 million. (Note that it takes several to many years from the time of radiation exposure for a cancer to manifest itself.)

Based on the same risk estimator, 1.5×10^{-4} excess fatal cancers are projected in the population living within 80 km (50 mi) of INEL from normal operations in 1993. To place this number into perspective, it can be compared with the number of fatal cancers expected in this population from all causes. The 1990 mortality rate associated with cancer for the entire U.S. population was 0.2 percent per year (Almanac 1993a:839). Based on this national mortality rate, the number of fatal cancers expected during 1992 from all causes in the population

Table 3.4.9–2. Radiation Doses to the Public From Normal Idaho National Engineering Laboratory Operation in 1993 (Committed Effective Dose Equivalent)

Members of the General Public	Atmospheric Releases		Liquid Releases		Total	
	Standard[a]	Actual	Standard[a]	Actual	Standard[a]	Actual
Maximally exposed individual (mrem)	10	0.030	4	0	100	0.030
Population within 80 km[b] (person-rem)	None	0.30	None	0	100	0.30
Average individual within 80 km[c] (mrem)	None	0.0025	None	0	None	0.0025

[a] The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10 mrem/yr limit from airborne emissions is required by the CAA, the 4 mrem/yr limit is required by the SDWA, and the total dose of 100 mrem/yr is the limit from all pathways combined. The 100 person-rem value for the population is given in proposed 10 CFR 834 (see 58 FR 16268). If the potential total dose exceeds this value, it is required that the contractor operating the facility notify DOE.
[b] In 1993, this population was approximately 121,500.
[c] Obtained by dividing the population dose by the number of people living within 80 km of the site.
Source: IN DOE 1994c.

living within 80 km (50 mi) of INEL was 243. This number of expected fatal cancers is much higher than the estimated 1.5×10^{-4} fatal cancers that could result from INEL operations in 1993.

Idaho National Engineering Laboratory workers receive the same doses as the general public from background radiation but also receive an additional dose from working in the facilities. Table 3.4.9–3 presents the average worker, maximally exposed workers, and total cumulative worker dose to INEL workers from operations in 1992. These doses fall within radiological regulatory limits (10 CFR 835). Based on a risk estimator of 400 fatal cancers per 1 million person-rem among workers (Section M.2.1.2), the number of fatal cancers to INEL workers from normal operations in 1992 is estimated to be 0.030.

Table 3.4.9–3. Radiation Doses to Workers From Normal Idaho National Engineering Laboratory Operation in 1992 (Committed Effective Dose Equivalent)

Occupational Personnel	Onsite Releases and Direct Radiation	
	Standard[a]	Actual
Average worker (mrem)	ALARA	14.2
Maximally exposed worker (mrem)	5,000	1,000
Total workers[b] (person-rem)	ALARA	75

[a] DOE's goal is to maintain radiological exposure as low as reasonably achievable.
[b] The number of badged workers in 1992 was approximately 5,270.
Source: 10 CFR 835; DOE 1993n:7.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in *The Idaho National Engineering Laboratory Site Environmental Report for Calendar Year 1993* (DOE/ID-12082[93]). The concentrations of radioactivity in various environmental media (including air, water, and soil) in the site region (onsite and offsite) are also presented in that document.

Chemical Environment. The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (for example, surface water during swimming, or soil through direct contact or via the food pathway). The baseline data for assessing potential health impacts from the chemical environment are those presented in Section 3.4.3.

Effective administrative and design controls that decrease hazardous chemical releases to the environment and help achieve compliance with permit requirements (for example, air emissions and NPDES permit requirements), contribute toward minimizing potential health impacts to the public. The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts to the public may occur during normal operations at INEL via inhalation of air containing hazardous chemicals released to the atmosphere by INEL operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water or direct exposure, are low relative to the inhalation pathway. At INEL, the risk to public health from water ingestion and direct exposure pathways is low because the surface water resource (Big Lost River) is not used for drinking or as a receptor for wastewater discharges.

Baseline air emission concentrations for hazardous chemicals and their applicable standards are included in the data presented in Section 3.4.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are in compliance with applicable guidelines and regulations. Information about estimating health impacts from hazardous chemicals is presented in Section M.3.

Exposure pathways to INEL workers during normal operation may include inhaling the workplace atmosphere and direct contact with hazardous materials associated with work assignments. The potential for health impacts varies from facility to facility and from worker to worker, and available information is not sufficient to allow a meaningful estimation and summation of these impacts. However, workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. INEL workers are also protected by adherence to OSHA and EPA standards that limit workplace atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring that reflects the frequency and amounts of chemicals utilized in the operational processes ensures that these standards are not exceeded. Additionally, DOE requirements ensure that conditions in the workplace are as free as possible from recognized hazards that cause, or are likely to cause, illness or physical harm. Therefore, worker health conditions at INEL are expected to be substantially better than required by the standards.

Health Effects Studies. No occupational epidemiological studies have been conducted at INEL to date, but two epidemiological studies have been conducted on communities surrounding INEL to determine if there are any excess cancers in the general population. No excess cancer mortality was reported, although excess cancer incidence was observed. However, no association of the excess cancer incidence with INEL was established. For a more detailed description of the study findings reviewed, refer to Section M.4.4.

Accident History. A recent study, the *Idaho National Engineering Laboratory Historical Dose Evaluation* (DOE/ID-12119), was conducted by DOE to estimate the potential offsite radiation doses for the entire operating history of INEL. Releases resulted from a variety of tests and experiments as well as a few accidents at INEL. The study concluded that these releases contributed to the total radiation dose during test programs of the 1950s and early 1960s. The frequency and size of releases has declined since that time. Based on information reported in the study, there have been no serious unplanned or accidental releases of radioactivity or other hazardous substance at INEL facilities in the last 10 years of operation. [Text deleted.]

Emergency Preparedness. Each DOE site has established an emergency management program that would be activated in the event of an accident. This program has been developed and maintained to ensure adequate response for most accident conditions and to provide response efforts for accidents not specifically considered.

The emergency management program incorporates activities associated with emergency planning, preparedness, and response.

Participating government agencies whose plans are interrelated with the INEL Emergency Plan for Action include the State of Idaho, Bingham County, Bonneville County, Butte County, Clark County, Jefferson County, the Bureau of Indian Affairs, and Fort Hall Indian Reservation. INEL contractors are responsible for responding to emergencies that occur at their facilities. When an emergency condition exists at a contractor facility, the Emergency Action Director is responsible for recognition, classification, notifications, and protective action recommendations. At INEL, emergency preparedness resources include fire protection from onsite and offsite locations and radiological and hazardous chemical material response. Emergency response facilities include an emergency control center at each facility, at the INEL warning communication center, and at the INEL site emergency operations center. There are also seven INEL medical facilities available to provide routine and emergency service.

3.4.10 WASTE MANAGEMENT

This section outlines the major environmental regulatory structure and ongoing waste management activities for INEL. A more detailed discussion of the ongoing waste management operations is provided in Section E.2.3. Table 3.4.10–1 presents a summary of waste management activities at INEL for 1992.

The Department is working with Federal and State regulatory authorities to address compliance and cleanup obligations arising from its past operations at INEL. DOE 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.

The EPA placed INEL on the NPL on December 21, 1989. DOE has entered into a Federal Facility Agreement and Consent Order with EPA and the State of Idaho to coordinate cleanup activities at INEL under a comprehensive strategy. This agreement integrates DOE's CERCLA response obligations with RCRA and *Hazardous Waste Management Act* of 1986 corrective action obligations. In this process, INEL has been divided into 10 waste area groups. Each group is subdivided into separate operable units composed of potential release sites that are considered together for assessment and cleanup activities. Ongoing assessments are characterizing the nature and extent of contamination. Aggressive plans are in place to achieve early remediation of sites that represent the greatest risk to workers and the public. The goal is to complete remediation of contaminated sites at INEL to support delisting from the NPL by 2019. INEL manages spent nuclear fuel and the following waste categories: high-level, TRU, low-level, mixed, hazardous, and nonhazardous. A discussion of the waste management operations associated with each of these categories follows.

Spent Nuclear Fuel. Spent nuclear fuel had been stored and processed at the ICPP. Processing was terminated with DOE's decision to halt reprocessing of spent nuclear fuel. INEL has received spent nuclear fuel from Three Mile Island, reactor tests, and the gas-cooled reactor and Naval Reactors Programs. Spent nuclear fuel from these programs and from reactor experiments at INEL is in storage in various locations. The bulk of the fuel is stored at the ICPP. Interim management of the spent nuclear fuel (pending the availability of a geologic repository) will be in accordance with the ROD published in the *Federal Register* on June 1, 1995 (60 FR 28680) and amended on March 8, 1996 (61 FR 9441), for the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE/EIS-0203-F). As a result of this ROD as amended, INEL will manage DOE's non-aluminum-clad spent fuel. This will require 114 shipments of aluminum-clad spent fuel to SRS and receipt of 1,133 shipments of non-aluminum-clad spent fuel. This spent fuel then will be placed in interim storage.

High-Level Waste. High-level waste at INEL was generated in the process of extracting useful isotopes from spent nuclear fuel at the ICPP. Most of this fuel was from the Naval Reactors Program. Most aqueous solutions from spent nuclear fuel processing and isotope extraction were concentrated by evaporation and separated into LLW and HLW streams in the Process Equipment Waste Evaporator. The liquid HLW is stored in subsurface tanks and then transformed into solid metallic oxides in a granular form by calcination. The calcine is stored in stainless steel bins in near-surface concrete vaults where it awaits further processing into a form suitable for emplacement in a Federal repository. As a result of the ROD for the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE/EIS-0203-F), calcination will resume until all liquid HLW is calcined. This will permit INEL to meet the requirements of a December 1991 consent order with the State of Idaho and EPA to cease use of existing storage tanks without constructing new tanks. Subsequently, the calcined waste will be treated to meet RCRA provisions on a schedule to be negotiated with the State of Idaho under the *Federal Facility Compliance Act*.

Table 3.4.10–1. Spent Nuclear Fuel and Waste Management Activities at Idaho National Engineering Laboratory

Category	1992 Generation (m^3)	Treatment Method	Treatment Capacity (m^3/yr)	Storage Method	Storage Capacity (m^3)	Disposal Method	Disposal Capacity (m^3)
Spent Nuclear Fuel	1.4 t[a,b] heavy metal	Conditioning and stabilization	Under assessment[c]	Pools, dry facility	261 t[c,d] heavy metal	None—High-Level Waste Program in the future	None
High-Level							
Liquid	560[b]	Evaporation, calcination	470[e]	Tank farm, after evaporation prior to calcination	13,400[f]	NA	NA
Solid[g]	None[b]	Decontamination, filter leach	238[h]	Bins inside concrete vaults	7,110[i]	None—High-Level Waste Program in the future	None
Transuranic							
Liquid	None	NA	NA	NA	NA	NA	NA
Solid	1	Decontamination, filter leach, calcination	595[j]	Asphalt pads and vaults in the ground or under earthen cover or tarps	206,000[k]	None—WIPP or alternate facility in the future	None
Low-Level							
Liquid	None	Evaporation, Ion exchange	11,600[l]	Tank farm after evaporation prior to calcination	With HLW	NA	NA
Solid	11,300	Incineration and compaction	3,350[m]	NA	NA	Onsite burial	180,000[n]
Mixed							
Liquid	5	Evaporation, fractionation, and calcination	11,600[l]	Tank farm	With HLW	None	None
Solid	51	Incineration and compaction	3,350[m]	Mixed waste storage facilities	115,000[o]	None	None

Table 3.4.10–1. Spent Nuclear Fuel and Waste Management Activities at Idaho National Engineering Laboratory—Continued

Category	1992 Generation (m^3)	Treatment Method	Treatment Capacity (m^3/yr)	Storage Method	Storage Capacity (m^3)	Disposal Method	Disposal Capacity (m^3)
Hazardous							
Liquid	Included in solid	Offsite and percolation ponds	Under assessment[c]	Percolation ponds	Under assessment[c]	Offsite	NA
Solid	835[p]	Offsite	NA	Hazardous waste storage facility	Under assessment[c]	Offsite	NA
Nonhazardous (Sanitary)							
Liquid	50,800	Percolation ponds	NA	NA	NA	NA	NA
Nonhazardous (Other)							
Liquid	Included in sanitary	Recycle	NA	NA	NA	NA	NA
Solid	62,000	Segregate and recycle	NA	NA	NA	Industrial and asbestos waste landfills	1,830,000 to 3,060,000[q]

[a] Spent nuclear fuel is normally expressed in metric tons, not cubic meters.
[b] 1993 data.
[c] Capacity will be increased to accommodate ROD from the *DOE Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement*, as amended.
[d] Current capacity includes ICPP, TAN, ANL-W, NRF, PBF, and TRA.
[e] New waste calcining facility.
[f] ICPP tank farm.
[g] Solid HLW produced by calcination of liquid HLW.
[h] ICPP debris treatment, HEPA filter leach.
[i] ICPP calcine bin sets.
[j] ICPP new waste calcining facility, debris treatment, HEPA filter leach.
[k] ANL-W, ICPP, RWMC.
[l] Liquid effluent treatment facility, potable water treatment, new waste calcining facility.
[m] ICPP debris treatment, HEPA filter leach, waste experimental reduction facility, lead treatment sodium processing facility, TAN cask dismantlement.
[n] 37,000 m^3 available as of 1991. Additional 67,000 m^3 expansion capacity potentially available.
[o] ANL-W, ICPP, PBF, RWMC, TAN.
[p] 760 m^3 recyclable.
[q] Remaining capacity.
Note: NA= not applicable; WERF= Waste Experimental Reduction Facility.
Source: 60 FR 28680; 61 FR 9441; DOE 1995i; DOE 1995v; IN DOE 1995d; INEL 1993a:5.

Transuranic Waste. Transuranic wastes are stored at the RWMC. This inventory represents more than half of the total DOE inventory. There is very little TRU waste generation at INEL. Most of the TRU waste in storage was received from RFETS. As a result of the ROD from the *Department of Energy Programmatic Spent Nuclear Fuel and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE/EIS-0203-F), and pending the ROD to be issued from the *DOE Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive Hazardous Waste* (DOE/EIS-0200-D) and in compliance with the *INEL Site Treatment Plan*, INEL may receive TRU waste from other facilities for treatment. After treatment, the waste would be returned to the generator for storage and eventual transport to a Federal repository. TRU wastes are currently being stored pending approval of WIPP as a repository for these wastes. Assuming WIPP is determined to be a suitable repository for these wastes, pursuant to the requirements of 40 CFR 191 and 40 CFR 268, these wastes will be treated to meet the WIPP WAC and packaged in accordance with DOE and DOT requirements for transport to WIPP for disposal depending on decisions made in the ROD associated with the supplemental EIS being prepared for the proposed continued phased development of WIPP for disposal of TRU waste.

Before 1970, when the AEC first required segregation of TRU wastes from other wastes, TRU wastes were buried in earthen trenches at the RWMC. This waste must be retrieved and repackaged to meet the current WIPP WAC. Wastes generated or received from offsite since 1970 are stored in a form designed for eventual retrieval. Since 1972, TRU wastes have been stored on Pad A in the RWMC. Most of this waste will require certification and repackaging. A new facility, the Advanced Mixed Waste Treatment Project, is being designed to accomplish this task. Some waste has radioactivity levels high enough that there are no certified or licensed transportation capabilities for it. Further study will be required for its eventual disposal. While the EPA has issued a notice of noncompliance for TRU waste stored at the RWMC, a proposed plan for the treatment and storage of TRU wastes has been documented in the Federal Facility Agreement and Consent Order, which addresses EPA and State of Idaho concerns, while also meeting DOE's concerns for worker protection. Some of the waste now handled as TRU or mixed TRU is alpha-contaminated LLW and mixed LLW. A strategy for treatment and disposal of this waste has yet to be established. Onsite and offsite treatment is being investigated.

Low-Level Waste. The bulk of LLW generated at INEL is the result of work in contaminated areas and consists of materials such as rags, bags, scrap metal, and used protective clothing. A large volume of LLW is generated in the D&D activities associated with environmental restoration. In addition, small amounts of LLW may be received from offsite for treatment and disposal. These materials must be treated by the operating facility to meet the WAC of the receiving facility, and conformity to these criteria must be verified by the receiving facility. Solid LLW at INEL is sent to the Waste Experimental Reduction Facility for compaction, sizing, incineration, and stabilization before shipment for disposal at the RWMC. The Waste Experimental Reduction Facility will be used to incinerate LLW. It is undergoing modifications to processes and procedures and is expected to be in operation in mid-1996.

Mixed Low-Level Waste. The volume of mixed LLW generated at INEL is small. Mixed LLW is stored in several areas onsite awaiting treatment capacities to be developed to treat the specific nature of a wide variety of different mixed waste streams. As a result of the ROD (60 FR 28680) from the *DOE Programmatic Spent Fuel and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final EIS* (DOE/EIS-0203-F), pending the ROD from the *DOE Waste Management Programmatic Environmental Impact Statement for the Managing Treatment, Storage, and Disposal of Radioactive Hazardous Waste* (DOE/EIS-0200-D), and in compliance with the consent order resulting from the *INEL Site Treatment Plan*, INEL may accept offsite mixed LLW for treatment. Waste residuals would be returned to the generator or shipped elsewhere for disposal. Mixed LLW is planned to be processed to RCRA Land Disposal Restriction (LDR) treatment standards through the Waste Experimental Reduction Facility incinerator beginning in June 1996, in the Advanced Mixed Waste Treatment Project beginning June 1998 through June 2000, and in the Sodium Processing Facility in March 1997. The use of commercial treatment facilities is also being considered. Large volumes of wastewater are processed in the Process Equipment Waste Evaporator, resulting in a concentrated mixed waste that is sent to the HLW tank farm and eventually stabilized in a fluidized bed calciner. Condensate from the Process Equipment Waste Evaporator is converted into a concentrated acidic solution in the Liquid ETF. This concentrate is either recycled as a scrubber solution for the calciner or sent to the HLW tank farm for storage. The Liquid ETF eliminates residual discharge of hazardous and radioactive contaminants into wastewater percolation ponds, which was the former practice, in accordance with a consent order signed on October 7, 1992. Current mixed waste plans are documented in the *INEL Site Treatment Plan*, which was prepared in compliance with the *Federal Facility Compliance Act* of 1992.

Hazardous Waste. Hazardous wastes are generated at separate facilities at INEL and are staged for shipment offsite to commercial RCRA-permitted treatment and disposal facilities. Offsite shipments are surveyed to determine that the wastes have no radioactive content (are not mixed waste). The major onsite RCRA-permitted hazardous waste storage facility is located in the CFA. The Waste Handling Facility Project at ANL-W will be implemented to handle ANL-W waste. A recycling program has been established, and in 1992, 760 m^3 (994 yd^3) of hazardous wastes were recycled.

Nonhazardous Waste. Nonhazardous waste generated at INEL facilities is disposed of onsite in a landfill complex in the CFA and at the Bonneville County landfill. The onsite landfill complex contains separate areas for sanitary, industrial, and asbestos waste. Sewage is directed to surface impoundments in accordance with terms of the October 7, 1992, consent order, and the water is allowed to evaporate. The resulting sludge is placed in the landfill. Solids are separated and reclaimed where possible. The goal of the INEL waste minimization program is to reduce the nonhazardous waste quantities generated by 50 percent over the next 5 years. The landfill area at INEL is 4.8 ha (12 acres) and is being expanded by 91 ha (225 acres) to provide capacity for at least the next 30 years (60 FR 28680).

3.5 PANTEX PLANT

Pantex is located in the Texas Panhandle in Carson County along U.S. Highway 60 and lies about 27 km (17 mi) northeast of downtown Amarillo. Figure 2.2.4–1 indicates the location of Pantex, and Figure 2.2.4–2 shows the location of primary facilities and industrial zones within the site's boundary.

Pantex lies on the Llano Estacado (staked plains) portion of the Great Plains. The topography at Pantex is relatively flat, characterized by rolling grassy plains and numerous natural playa basins. The term "playa" is used to describe the more than 17,000 ephemeral lakes in the Texas Panhandle, usually less than 1 km (0.6 mi) in diameter, that receive water runoff from the surrounding area. The region is a semiarid farming and ranching area. Pantex is surrounded by agricultural land, but several significant industrial facilities are also located nearby.

Pantex is Government-owned and contractor-operated. The Mason & Hanger-Silas Mason Company has been the operating contractor since 1956. Since 1991, the environmental, health, and safety programs have been subcontracted to Battelle Memorial Institute.

Pantex was first used by the U.S. Army for loading conventional ammunition shells and bombs from 1942 to 1945. In 1951, the AEC arranged to begin rehabilitating portions of the original plant and constructing new facilities for nuclear weapons operations. The current missions are shown in Table 3.5–1. Weapons assembly, disassembly, and stockpile surveillance activities involve handling (but not processing) of encapsulated uranium, Pu, and tritium, as well as a variety of nonradioactive hazardous or toxic chemicals. Environmental restoration of the facility is a recent addition to operations at the plant.

Table 3.5–1. Current Missions at Pantex Plant

Mission	Description	Sponsor
Plutonium Storage	Provide storage of pits from dismantled nuclear weapons	Assistant Secretary for Defense Programs
High Explosive(s) Components	Manufacture for use in nuclear weapons	Assistant Secretary for Defense Programs
Weapon Assembly	Assemble new nuclear weapons for the stockpile	Assistant Secretary for Defense Programs
Weapon Maintenance	Retrofit, maintain, and repair stockpile weapons	Assistant Secretary for Defense Programs
Quality Assurance	Stockpile quality assurance testing and evaluation	Assistant Secretary for Defense Programs
Weapon Disassembly	Disassemble stockpile weapons as required	Assistant Secretary for Defense Programs
Test/Training Programs	Assemble nuclear weapon-like devices for training	Assistant Secretary for Defense Programs
Weapons Dismantlement	Dismantle nuclear weapons no longer required	Assistant Secretary for Defense Programs
Development Support	Provide support to design agencies as requested	Assistant Secretary for Defense Programs
Environmental Management	Environmental Restoration and Waste Management Activities	Assistant Secretary for Environmental Management

Source: PX 1995a:2

Department of Energy Activities. All DOE activities at Pantex, except for environmental restoration and some waste management programs, fall under the DOE Office of the Assistant Secretary for Defense Programs (DP). Historically, DOE's national security mission for Pantex primarily included assembly and delivery to DoD of a variety of nuclear weapons. Today, the primary role of Pantex is the disassembly of U.S. nuclear weapons being returned to DOE by DoD. This operation is in compliance with the negotiated downsizing of the United States and the former Soviet nuclear forces. Disassembly of a nuclear weapon includes removal of the fissile material. Subsequent storage of pits is the mission of major relevance to this PEIS.

Other activities that have been, and will continue to be, conducted under DOE's national security mission include certain maintenance and monitoring activities of the remaining nuclear weapons stockpile, modification and assembly of existing nuclear weapons systems, and production of HE components for nuclear weapons. DOE also conducts quality evaluation of weapons, quality assurance testing of weapons components, and R&D activities supporting nuclear weapons at the plant. DOE's responsibilities are mandated by statutes, Presidential directives, and congressional authorization and appropriations.

Waste management operations at Pantex in the near term (1996 to 1997) would add facilities to enhance capabilities to adequately handle existing waste streams. Improved facilities for hazardous waste staging, treatment, and storage would be coupled with increased use of commercial offsite facilities to treat mixed waste streams. The change in mission emphasis from assembly to disassembly of nuclear weapons would cause an increase in some waste streams and a decrease in others. New waste-handling capacities would be required to meet this need, but upon completion of the current backlog of dismantlements due to stockpile reduction, waste generation would decrease.

Non-Department of Energy Activities. Texas Tech University pursues agricultural activities on both DOE-owned and DOE-leased property.

3.5.1 LAND RESOURCES

Land Use. Pantex is located within Carson County in the Panhandle region of Texas, 27 km (17 mi) east-northeast of downtown Amarillo. Pantex operational activities are situated within 6,030 ha (14,900 acres) of land, of which approximately 3,683 ha (9,100 acres) are owned by the Federal Government and the remaining 2,347 ha (5,800 acres) are leased from Texas Tech University primarily to provide a safety and security buffer zone. All owned and leased buildings on the site are administered, managed, and controlled by DOE. DOE owns an additional remote tract of 436 ha (1,077 acres) of undeveloped land at Pantex Lake located approximately 4 km (2.5 mi) northeast of the main plant site. This property is held by DOE to retain the water rights. Total Pantex area equals 6,466 ha (15,977 acres).

Existing Land Use. Generalized land uses at Pantex and the vicinity are shown on Figure 3.5.1–1. The Texas Tech Agriculture Research operations use DOE-owned land not actively used for Pantex operations, as well as the property leased to DOE for agricultural purposes. Agricultural activities generally consist of dry farming and livestock grazing. A limited amount of crop irrigation occurs. Soil map units classified as prime farmland soils by the U.S. Department of Agriculture, National Resources Conservation Service exist onsite. However, the potential for farmland conversion by activities at Pantex is not an issue since Pantex is exempt from compliance with the *Farmland Protection Policy Act* (PX DOE 1995a:1). Land area leased from Texas Tech also contains one residence and one trailer located approximately 6 km (3.7 mi) southwest of the weapons assembly and disassembly and HE production core (PX DOE 1996b:4-94).

The land surrounding Pantex is rural private property. The closest offsite residences are approximately 48 m (157 ft) from the plant boundary in the western and northeastern sectors. Most of the surrounding land is prime farmland when irrigated, with the exception of the area northwest of the plant site, which is rangeland. Some property owners have enrolled their land in the Federal Conservation Reserve Program. Under terms of the program, the land is placed in a dormant state for 10 years and cannot be cultivated or grazed. The majority of the land, however, is cultivated. The land is generally dry farmed; however, some fields are irrigated from local playas or from the Ogallala Aquifer. The Iowa Beef Packers, Inc., packing plant is the only industrial activity within 3.2 km (2.0 mi) of Pantex.

Land-Use Planning. Within the State of Texas, land-use planning occurs only at the municipal level. The city of Amarillo comprehensive plan has designated land for future growth. The direction for future residential development is anticipated to occur toward the southwest, away from Pantex. The East Planning Area of the city, which extends to within 3.2 km (2 mi) of Pantex, has historically been one of the slower growing residential areas. Because of the presence of the airport and industrial use in this area, the comprehensive plan encourages compatible use rather than residential use. The largest residential area in the East Planning Area is the base housing of the former Amarillo Air Force Base. The base housing has been converted to rental housing and is located approximately 8 km (5 mi) southwest of the plant boundary.

Visual Resources. Pantex is sited within a landscape typical of the High Plains region of Texas consisting of cultivated cropland and rangeland. Pantex consists of operational facilities of the plant and the inactive facilities of the former World War II ammunition plant. These industrial land uses are surrounded by cropland and rangeland that blend into the offsite viewscape. The developed areas of Pantex are consistent with VRM Class 5 designation. The remainder of Pantex ranges from VRM Class 3 to Class 4.

Public access within Pantex and its buffer areas is strictly controlled and limited to authorized personnel, visitors, and the agricultural lessee and sublessees. Public access adjacent to the plant perimeter is limited to three Texas Farm-to-Market Roads and U.S. Route 60. The most visible, and therefore most sensitive, viewpoint of Pantex facilities is located 2.4 km (1.5 mi) southeast at the intersection of U.S. Route 60 and Texas Farm-to-Market Road 2373. U.S. Route 60 is part of the Texas Plains Trail, a scenic road with Pantex a designated point of interest. The view of the plant along this highway is visible, appearing as low clusters of buildings on a flat horizon. Because of their height, the cylindrical water towers are the most visible feature. The operations areas are well defined at night by the intense security lighting. The plant operations areas are also visible from Interstate 40, with the closest viewpoint being the rest area approximately 10 km (6 mi) away. This viewpoint is similar to that described for U.S. Route 60, but because of the greater distance, the plant facilities are not as prominent. The plant facilities are generally visible from the low-density rural housing that surrounds the site.

3.5.2 SITE INFRASTRUCTURE

Baseline Characteristics. Section 3.5 describes current Pantex missions. Baseline characteristics are shown in Table 3.5.2–1.

Table 3.5.2–1. Pantex Plant Baseline Characteristics

Characteristics	Current Usage	Site Availability
Transportation		
Roads (km)	76	76
Railroads (km)	27	27
Electrical		
Energy consumption (MWh/yr)	84,420	201,480
Peak load (MWe)	13.6	23
Fuel		
Natural gas (m^3/yr)	14,600,000	289,000,000
Oil (l/yr)	1,775,720	1,775,720
Coal (t/yr)	0	0
Steam (kg/hr)	59,524	68,040

Source: PX 1995a:1; PX DOE 1995d; PX DOE 1996b.

Pantex is tied to the Burlington Northern Santa Fe Railroad, formerly known as the Atchison, Topeka, and Santa Fe Railroad, through a spur that enters the plant from the southwest running just north of U.S. Highway 60. This spur provides access to the entire Burlington Northern Santa Fe system as well as to other railroads. Currently, the spur is being used only for concrete shipments.

Electric generating capacities by fuel types within the sub-regional power pool supplying power to Pantex provide the larger fractions by coal, oil, and gas turbine production, respectively. The remaining is provided by small amounts of nuclear, hydroelectric, and other sources. The sub-regional electric power pool from which Pantex draws its power is the West Central Power Pool. The sub-regional power pool electrical summary is shown in Table 3.5.2–2.

Natural gas at Pantex is supplied by Anthem Energy. From calendar year 1987 through fiscal year 1994, gas use has generally increased from a low of 11,889 million m^3 (424,605 million ft^3) in 1988 to a high of 15,033 million m^3 (536,893 million ft^3) in 1993. Both current and future supplies appear to be adequate. Much of the region is underlain by natural gas deposits, and there are consequently many small local suppliers in addition to the major companies.

Five wells, which are pumped into a common line and into ground storage tanks, supply water to Pantex. There are a total of 24.2 million l (6.4 million gal) of ground storage capacity. Two elevated storage tanks totaling 1,374,000 l (363,000 gal) provide pressure to the system. Water use at Pantex has ranged from 1,052 to 1,192 million l (278 to 315 million gal) annually from 1989 through 1993. In addition, water sold to Texas Tech University ranged from 235 to 344 million l (62 to 91 million gal) annually during the same period.

Operations at Pantex are housed in 476 buildings, containing 230,200 m^2 (2,483,000 ft^2) of work space. Magazines in Zone 4 consist of 95 buildings used for staging nuclear weapons, storage of explosives, and interim storage of pits. Current pit storage capability consists of 22 Modified Richmond and Steel Arch Construction magazines, all of which have necessary utility support and material access control. Current capacity for pit storage is 20,000 pits.

Table 3.5.2–2. West Central Sub-Regional Power Pool Electrical Summary

Characteristics	Energy Production
Type Fuel[a]	
Coal	59%
Nuclear	7%
Hydro/geothermal	1%
Oil/gas	32%
Other[b]	1%
Total Annual Production	107,607,000 MWh
Total Annual Load	104,681,000 MWh
Energy Exported Annually[c]	2,926,000 MWh
Generating Capacity	24,642 MWe
Peak Demand	20,578 MWe
Capacity Margin[d]	4,064 MWh

[a] Percentages do not total 100 percent due to rounding.
[b] Includes power from both utility and non-utility sources.
[c] Energy exported is not the difference of production and load due to negative net pumped storage.
[d] Capacity margin is the amount of generating capacity available to provide for scheduled maintenance, emergency outages, system operating requirements, and unforeseen electrical demand.

Source: NERC 1993a.

3.5.3 AIR QUALITY AND NOISE

Meteorology and Climatology. The climate at Pantex and in the surrounding region is characterized as semi-arid with hot summers and relatively cold winters. The average annual temperature in the Amarillo region is 13.8 °C (56.9 °F); temperatures range from an average daily minimum of -5.7 °C (21.8 °F) in January to an average daily maximum of 32.8 °C (91.1 °F) in July. The average annual precipitation is 49.7 cm (19.6 in). Prevailing wind directions at Pantex are from the south to southwest. The average annual windspeed is 6.0 m/s (13.5 mph) (NOAA 1994c:3). Additional information related to meteorology and climatology at Pantex is presented in Appendix F.

Ambient Air Quality. Pantex is located within the Amarillo-Lubbock Intrastate AQCR (#211), which is currently designated as "attainment" or "unclassified" by EPA (40 CFR 81.344) with respect to the NAAQS for criteria pollutants (40 CFR 50). Appendix F lists the NAAQS for these criteria pollutants. These standards have been adopted by the State of Texas (TX NRCC 1995b:28). There are no PSD Class I areas within 100 km (62 mi) of Pantex.

Historically, the primary emission sources of criteria pollutants at Pantex are the steam plant boilers, the explosives burning operation, and emissions from onsite vehicles (PX DOE 1983a:3-8,3-11). Potential emission sources of hazardous/toxic air pollutants include the high explosives synthesis facility, the explosives burning operation and paint spray booths, miscellaneous laboratories, and other small operations. With the exception of thermal treatment of HE at the Burning Ground, most stationary points of nonradioactive atmospheric releases are from fume hoods and building exhaust systems with HEPA filters.

Table 3.5.3–1 presents the baseline ambient air concentration for criteria pollutants and other pollutants of concern at Pantex. As shown in the table, baseline concentrations are in compliance with applicable guidelines and regulations.

Noise. Major noise emission sources within Pantex include various industrial facilities, equipment, and machines (for example, cooling systems, transformers, engines, pumps, boilers, steam vents, construction and materials handling equipment, vehicles, weapons firing, alarms, and explosives detonation). Most Pantex industrial facilities are at a sufficient distance from the site boundary to make noise levels at the boundary from these sources barely distinguishable from background noise. However, some noise from explosives detonation can be heard at residences north of the site and weapons firing can be heard at residences west of the site.

The acoustic environment along the Pantex boundary and at nearby residences away from traffic noise is typical of a rural location, with DNL in the range of 35 to 50 dBA (EPA 1974a:B-4). Noise survey results in areas adjacent to Pantex indicate that ambient sound levels are generally low, with natural sounds and distant traffic being the primary sources. Traffic, aircraft, trains, and agricultural activities result in higher short-term levels especially near roads (PX DOE 1995i:11-1,11-23). Traffic is the primary source of noise at the site boundary and at residences located near roads. Plant traffic contributes little to overall traffic noise. However, traffic noise is expected to dominate sound levels along major roads in the area, such as U.S. Route 60. The residents that have the highest potential for being affected by noise from plant traffic along Pantex access routes are those living along Farm-to-Market Roads 2373 and 683.

Other sources of noise include aircraft, wind, insect activity, and agricultural activity. Except for the prohibition of nuisance noise, neither the State of Texas nor its local governments have established any regulations that specify acceptable community noise levels.

Table 3.5.3–1. Comparison of Baseline Ambient Air Concentrations With Most Stringent Applicable Regulations or Guidelines at Pantex Plant, 1993

Pollutant	Averaging Time	Most Stringent Regulation or Guideline[a] (μg/m³)	Baseline Concentration (μg/m³)
Criteria Pollutants			
Carbon monoxide	8-hour	10,000[b]	161
	1-hour	40,000[b]	924
Lead	Calendar Quarter	1.5[b]	0.01
Nitrogen dioxide	Annual	100[b]	0.90
Ozone	1-hour	235[b]	[c]
Particulate matter less than or equal to 10 microns in diameter	Annual	50[b]	8.73
	24-hour	150[b]	88.5
Sulfur dioxide	Annual	80[b]	<0.01
	24-hour	365[b]	<0.01
	3-hour	1,300[b]	<0.01
	30-minute	1,045[d]	<0.01
Mandated by the State of Texas			
Hydrogen fluoride	30-day	0.8[d]	<0.27
	7-day	1.6[d]	<0.27
	24-hour	2.9[d]	0.27
	12-hour	3.7[d]	0.38
	3-hour	4.9[d]	1.52
Hydrogen sulfide	30-minute	111[d]	[e]
Sulfuric acid	24-hour	15[d]	[e]
	1-hour	50[d]	[e]
Total suspended particulates	3-hour	200[d]	[e]
	1-hour	400[d]	[e]
Hazardous and Other Toxic Compounds			
1,1,1-Chloroethane	30-minute[f]	500[d]	127
	Annual	50[d]	0.53
1,1,2-Trichloroethane	30-minute[f]	550[d]	17.3
	Annual	55[d]	0.08
2-Nitropropane	30-minute[f]	50[d]	8.55
	Annual	5[d]	0.04
Alcohols	30-minute[f]	[g]	195
	Annual	[g]	0.70
Benzene	30-minute[f]	30[d]	19.40
	Annual	3[d]	0.05
Carbon disulfide	30-minute[f]	30[d]	22.60
	Annual	3[d]	0.09
Carbon tetrachloride	30-minute[f]	126[d]	19.7
	Annual	13[d]	0.08
Chlorobenzene	30-minute[f]	460[d]	19.5
	Annual	46[d]	0.08

Table 3.5.3–1. Comparison of Baseline Ambient Air Concentrations With Most Stringent Applicable Regulations or Guidelines at Pantex Plant, 1993—Continued

Pollutant	Averaging Time	Most Stringent Regulation or Guideline[a] (μg/m³)	Baseline Concentration (μg/m³)
Hazardous and Other Toxic Compounds (continued)			
Chromium	30-minute[f]	1[d]	0.10
	Annual	0.1[d]	0.002
Cresol	30-minute[f]	5[d]	0.41
	Annual	[h]	0.002
Cresylic acid	30-minutef	5[d]	0.51
	Annual	[h]	0.002
Dibenzofuran	30-minute[f]	[h]	0.001
	Annual	[h]	0.00002
Ester glycol ethers	30-minute[f]	[h]	35.9
	Annual	[h]	0.15
Ethyl benzene	30-minute[f]	2,000[d]	31.1
	Annual	434[d]	0.13
Ethylene dichloride	30-minute[f]	40[d]	9.58
	Annual	4[d]	0.04
Formaldehyde	30-minute[f]	15[d]	0.37
	Annual	1.5[d]	0.004
Hydrogen chloride	30-minute[f]	75[d]	5.98
	Annual	0.1[d]	0.09
Ketones	30-minute[f]	[h]	33.4
	Annual	[h]	0.14
Mercury	30-minute[f]	0.5[d]	0
	Annual	0.05[d]	0
Methanol	30-minute[f]	2,620[d]	245
	Annual	262[d]	0.58
[Text deleted.]			
Methyl ethyl ketone	30-minute[f]	3,900[d]	1,400
	Annual	590[d]	5.10
Methylene chloride	30-minute[f]	260[d]	180
	Annual	26[d]	0.74
Methyl isobutyl ketone	30-minute[f]	2,050[d]	4.45
	Annual	205[d]	0.02
Naphthalene	30-minute[f]	440[d]	0.005
	Annual	50[d]	0.0001
[Text deleted.]			
Nitrobenzene	30-minute[f]	24[d]	0.51
	Annual	5[d]	0.002
Phenol	30-minute[f]	154[d]	0.03
	Annual	19[d]	0.0006
Tetrachloroethylene	30-minute[f]	340[d]	17.6
	Annual	34[d]	0.07

Table 3.5.3–1. Comparison of Baseline Ambient Air Concentrations With Most Stringent Applicable Regulations or Guidelines at Pantex Plant, 1993—Continued

Pollutant	Averaging Time	Most Stringent Regulation or Guideline[a] ($\mu g/m^3$)	Baseline Concentration ($\mu g/m^3$)
Hazardous and Other Toxic Compounds (continued)			
Toluene	30-minute[f]	1,880[d]	568
	Annual	188[d]	1.73
Trichloroethene	30-minute[f]	[h]	51.1
	Annual	[h]	0.21
Trichloroethylene	30-minute[f]	1350[d]	51.1
	Annual	135[d]	0.21
Triethylamine	30-minute[f]	40[d]	1.08
	Annual	4[d]	0.002
Xylene	30-minute[f]	3,700[d]	145
	Annual	434[d]	0.47

[a] The more stringent of the Federal and State standard is presented if both exist for the averaging time.
[b] Federal and State standard.
[c] Ozone, as a criteria pollutant, is not directly emitted or monitored by the site. See Section 4.1.3 for a discussion of ozone-related issues.
[d] State standard.
[e] Data not available from source document.
[f] 1-hour predicted concentrations were used for the 30-minute standard.
[g] The Texas Natural Resources Conservation Commission does not have an Effects Screening Level (ESL) for the family of alcohols. If ambient levels of air contaminants exceed the screening levels, it does not necessarily indicate a problem. It is just a trigger for a more in-depth review. The most stringent ESL for a single alcohol may be exceeded if applied to the family of alcohols.
[h] No State standard for indicated averaging time.
Source: 40 CFR 50; PX DOE 1996b; TX ACB 1987a; TX NRCC 1992a; TX NRCC 1995a.

3.5.4 WATER RESOURCES

Surface Water. There are no streams or rivers at Pantex, and all site water requirements are met by groundwater. All surface water drains to playas, natural closed depressions that collect runoff to form ephemeral lakes. There are seven playas associated with Pantex. Playas 1 through 3 are located on DOE-owned property, Playas 4 and 5 are on DOE-leased property, Pantex Lake (also a playa) is located approximately 4 km (2.5 mi) northeast of the site boundary, and Pratt Lake is located just north of the site boundary (Figure 3.5.4–1). The only major stream in the area is the Canadian River, which is located approximately 40 km (25 mi) north of Pantex. Since surface runoff at the Plant flows into all playa basins, the Canadian River is not affected by activities at Pantex.

Playas are a significant part of the surface and subsurface hydrologic systems at Pantex. All playas at the site receive stormwater runoff from Pantex vicinity. Playa 1 receives continuous discharges from the Pantex Wastewater Treatment Facility. Steam condensate, noncontact cooling water from buildings, and stormwater runoff are directed to Playas 1, 2, and 4. Playa 3 receives stormwater runoff from the Pantex Burning Ground. Pantex activities have not discharged to Playa 5, but past activities included discharge of treated effluents to Pantex Lake. There are also a number of playas adjacent to Pantex that receive drainage from perimeter portions of the site. Playas provide a source of groundwater recharge, although the rate of recharge is unknown. Studies currently are being conducted to determine this rate.

Because there are no onsite or nearby flowing streams, floodplains exist only in association with the playas. A previous floodplain assessment concluded that the only incidence of flooding would be at some sites including the wastewater treatment plant of Playa 1 and some relict World War II bunkers southwest of Playa 4 (LLNL 1988a:XV). This limited flooding would not affect the operations at Pantex. The 500-year floodplain is also associated with the playas; its boundaries generally follow those of the 100-year floodplain and typically extend only up to several hundred feet beyond the 100-yr boundaries. The exception is Playa 3 where the 500-yr and Standard Project Flood runoff into Playa 3 will overflow out of the drainage basin creating shallow (less than 30 cm [1 ft]) flooding of the drainage basins for Playas 1 and 2. The 100-year floodplain associated with Pratt Lake extends into the far northeast corner of Pantex.

Surface Water Quality. The NPDES program of the CWA is administered by EPA in the State of Texas. In addition, discharge of wastewaters to waters defined as "Waters of the United States" within the State of Texas requires a wastewater discharge permit from the Texas Natural Resources Conservation Commission (TNRCC) in accordance with the Texas Water Code (PX Battelle 1992a:2-12).

In November 1990, Pantex submitted an NPDES permit application for Playas 1, 2, and 4, which is currently under review by Region 6 of EPA. Pantex also submitted an NPDES stormwater discharge permit application in October 1991. The NPDES stormwater permit was issued in February 1995.

The TNRCC allows Pantex to discharge wastewaters into Playas 1 and 2. In December 1990, Pantex filed an application to modify its wastewater discharge permit to allow discharge of both industrial wastewater and rainwater runoff into Playa 4. An application for a renewal of the TNRCC wastewater discharge permit #2296 is on file and is currently under negotiation. Surface water quality sampling results from 1994 confirm that Pantex was in compliance with all discharge water quality regulations for Playa 1. With exception of a high water level in Playa 1 in July 1994, due to a rainfall event, all permit requirements were met (PX DOE 1995d:2-10).

Surface water monitoring is conducted at Playas 1, 2, 3, at the main plant, at Pantex Lake, and at Bushland Playa, an offsite control playa (60 km [37.5 mi] southwest of Pantex) used for comparative purposes. There are some differences in the parameters monitored among the playas, but the results of the 1994 monitoring activities at Playa 1 are presented as representative of the water quality of all the playas at Pantex (Table 3.5.4–1). Bushland Playa contained water in August, September, November, and December in 1994; results were within historical limits.

Table 3.5.4–1. Summary of Playa 1 Surface Water Quality Monitoring at Pantex Plant, 1994

Parameter	Unit of Measure	Water Quality Criteria[a]	Water Body Concentration	
			High	Low
Alpha (gross)	pCi/l	15[b]	7±3	0±4
[Text deleted.]				
Ammonia (as N)	mg/l	NA	1.5	0.095
Arsenic	mg/l	0.05[b,c]	0.01	0.004
Barium	mg/l	2.0[b]	0.3	0.1
Beta (gross)	pCi/l	50[d]	22±4	8±6
[Text deleted.]				
Cadmium	mg/l	0.005[b]	<dL[e]	<dL[e]
Chloride	mg/l	250[f]	270	16
Chromium	mg/l	0.1[b]	0.01	0.003
Copper	mg/l	1.0[f]	0.01	0.005
Cyanide	mg/l	0.2[b]	0.009	0.005
Fluoride	mg/l	2[f],4[b]	2.4	0.48
HMX*	mg/l	NA	<dL[e]	<dL[e]
Iron	mg/l	0.3[f]	11	0.51
Lead	mg/l	0.015[b]	0.005	0.002
Manganese	mg/l	0.05[f]	0.4	0.07
Mercury	mg/l	0.002[b]	0.0002	0.0002
Oil and grease	mg/l	NA	14	0.48
PETN*	mg/l	NA	<dL[e]	<dL[e]
Plutonium-239/240	pCi/l	1.2[g]	0.03±0.01	0±0.03
Radium-226	pCi/l	5.0[b]	0.6±0.4	0.1±0.2
Radium-228	pCi/l	5.0[b]	1.1±0.7	0±0.5
RDX*	mg/l	NA	<dL[e]	<dL[e]
Sulfate (as SO_4)	mg/l	250[f]	80.2	4
TNT*	mg/l	NA	<dL[e]	<dL[e]
Tritium	pCi/l	80,000[g]	0.23±0.21	0±0.15
Uranium-234	pCi/l	20[g]	4.3±0.4	0±0
Uranium-238	pCi/l	24[g]	2.1±0.3	0.1±0.1
Zinc	mg/l	5.0[f]	0.08	0.006

[a] For comparison purposes only.

[b] National Primary Drinking Water Regulations (40 CFR 141).

[c] Texas State water quality criteria. Parameters are considered in exceedance only when their concentrations surpass State water quality criteria. General criteria do not apply to instances in which surface water, as a result of natural phenomena, exhibit characteristics beyond the limits established.

[d] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).

[e] All samples were below detection limit. Detection limits varied throughout the year.

[f] National Secondary Drinking Water Regulations (40 CFR 143).

[g] DOE DCG for water (DOE Order 5400.5). DCG values are based on a committed effective dose equivalent of 100 mrem per year; however, because the drinking water maximum contaminant level is based on 4 mrem per year, the number listed is 4 percent of the DCG. All concentrations of radionuclides are determined by subtracting the instrument background environmental level from the monitored concentration. A negative or zero incremental concentration means that the concentration at the sampling location is equivalent to the environmental level.

Note: *=high explosive(s) compounds; NA=not applicable; dL= detection limit.

Source: PX DOE 1995d.

Surface Water Rights and Permits. Water rights in Texas fall under the Doctrine of Prior Appropriations. Under this doctrine, the user who first appropriated water for a beneficial use has priority to use available water supply over a user claiming rights at a later time. Courts also recognize riparian rights legally granted from Spanish-American Agreements. The TNRCC is the administrator for water rights and is the permit-issuing authority.

Groundwater. Pantex is located on the Texas High Plains aquifer system, which is the southernmost extension of a regional aquifer that extends from Texas to South Dakota (PX WDB 1993a:1). The two principal water-bearing units beneath Pantex and adjacent areas are the Ogallala Aquifer and the Dockum Group Aquifer. In addition, perched groundwater occurs locally, particularly under the southeast portion of Pantex, at approximate depths ranging from 64 to 88 m (210 to 290 ft) (PX DOE 1996b:4-65). The occurrence of perched groundwater has been attributed to a fine-grained zone of silty sands and clays that limits the downward movement of groundwater. Perched groundwater collects in buried gravel and sand channel deposits that are on top of the fine-grained zone. Deep wells in the northeast corner of Pantex, completed at depths of 183 to 244 m (600 to 800 ft) into the Ogallala Formation, have provided the water supply at Pantex for over 40 years. In 1994, Pantex reported a total production of 836 million l (221 million gal) of water from onsite production wells (PX DOE 1996b:4-77) and has a capacity to produce 1,900 million l/yr (500 million gal/yr) (PX DOE 1995g:10).

The Ogallala Aquifer beneath Pantex has not been classified by EPA. However, it is the only source of drinking water for Pantex. Depth to water in the Ogallala Aquifer ranges from 104 m (340 ft) at the southern boundary of DOE-leased property at Pantex to 140 m (460 ft) at the northern boundary (PX DOE 1996b:4-57). The saturated thickness of the Ogallala Formation ranges from 15.2 m (50 ft) to more than 120 m (400 ft), and in some areas it is capable of yielding in excess of 4,000 lpm (1,060 gal/min), or 2.1 billion l/yr (554.8 million gal/yr) (PX DOE 1996b:4-69). Estimates of annual recharge rates to the Ogallala Aquifer vary from 0.02 to 4.1 cm/yr (0.01 to 1.6 in/yr) (PX DOE 1996b:4-69, 4-71) based on earlier studies that investigated slow regional infiltration of precipitation and recent studies that explored percolation of water through playa lakes and leakage from the Dockum Group Aquifer into the Ogallala Aquifer (PX WDB 1993a:2).

The withdrawal of water from the Ogallala Aquifer continues to exceed recharge, causing water levels to decline in the Pantex area at a rate of approximately 0.6 to 1.5 m/yr (2 to 5 ft/yr) (PX DOE 1995d:1-9). From 1980 to 1990, the city of Amarillo well field north of Pantex experienced up to 20 m (60 ft) of water-level decline, which may have contributed to a depression in the groundwater surface northeast of Pantex (PX WDB 1993a:11). In 1990, the recoverable volume of water in storage and available for use in the Ogallala Aquifer in the High Plains aquifer system was estimated at 515 trillion l (136 trillion gal) (PX DOE 1996b:4-71). The groundwater flow direction beneath Pantex is to the northeast (PX DOE 1995d:1-8). Figure 3.5.4–2 shows the direction of the groundwater flow in the Ogallala Aquifer beneath Pantex.

An agreement between Pantex and the city of Amarillo is currently being negotiated to develop reclaimed wastewater from the city of Amarillo Hollywood Road Wastewater Treatment Plant. The plant is currently discharging approximately 9,671 million l/yr (2,555 million gal/yr) of the advanced treated wastewater and will be discharging approximately twice that much by 2010. The use of reclaimed wastewater could curtail the annual decline rate of the Ogallala Aquifer.

Groundwater Quality. Pantex's groundwater monitoring program includes monitoring wells distributed throughout the facility and onsite Ogallala production wells. Groundwater samples collected from the monitoring wells that tap the perched and Ogallala aquifers are analyzed for a standard suite of parameters and constituents, including volatile organics, HE, pesticides, herbicides, semivolatile organics, trace metals, radioactive materials (including gross alpha and gross beta measurements), and field parameters (including total dissolved solids and pH).

Historically, only limited metal contamination has been found in some of the wells monitoring the Ogallala Aquifer. Table 3.5.4–2 shows the water quality in the Ogallala Aquifer in 1994. Groundwater samples from the perched zone, however, contain a variety of constituents that are either above background levels or drinking

Table 3.5.4–2. Groundwater Quality Monitoring (Ogallala Aquifer Wells) at Pantex Plant, 1994

Parameter	Unit of Measure	Water Quality Criteria and Standards[a]	Drinking Water Wells		Monitoring Wells	
			High	Low	High	Low
1,2-Dichloroethane	mg/l	0.005[b]	<0.005	<0.005	<0.005	<0.005
Barium	mg/l	2.0[b]	0.16	0.1	0.19	0.12
Chromium	mg/l	0.1[b]	0.007	<0.005	0.007	<0.005
Copper	mg/l	1.0[c]	0.046	<0.005	0.01	<0.005
HMX*	mg/l	NA	<0.020	<0.020	<0.020	<0.020
Iron	mg/l	0.3[c]	0.06	<0.01	1.49	<0.01
Lead	mg/l	0.015[b]	<0.005	<0.005	0.007	<0.005
Nitrate	mg/l	10[b]	1.85	1.37	2.19	0.767
pH	pH units	6.5-8.5[c]	7.7	7	8.1	6.7
RDX*	mg/l	NA	<0.020	<0.020	<0.020	<0.020
Sulfate	mg/l	250[c]	23	21	26	16
Total dissolved solids	mg/l	500[c]	320	240	384	210
Total organic carbon	mg/l	NA	1	<1	2	<1
Total organic halogens	mg/l	NA	5	<1	23	<3
Trichloroethylene	mg/l	0.005[b]	<0.005	<0.005	<0.005	<0.005
Tritium	pCi/l	80,000[d]	0.25	<MDA[e]	0.14	<MDA[e]
Uranium-234	pCi/l	20[d]	4.8	3.7	5.5	0.8
Uranium-238	pCi/l	24[d]	2.8	1.5	2.8	0.9
Zinc	mg/l	5.0[c]	0.18	<0.005	1.9	<0.005

[a] For comparison purposes only.
[b] National Primary Drinking Water Regulations (40 CFR 141).
[c] National Secondary Drinking Water Regulations (40 CFR 143).
[d] DOE DCG for water (DOE Order 5400.5). DCG values are based on 100 mrem per year; however, because the drinking water maximum contaminant level is based on 4 mrem per year, the number listed is 4 percent of the DCG.
[e] Results were less than the Minimum Detectable Activity (MDA).
Note: *=high explosive(s) compounds; NA=not applicable.
Source: PX DOE 1995d.

water standards or are not naturally occurring. These include 1,2-dichloroethane, trichloroethylene, chromium, iron, and the HE RDX and HMX. Table 3.5.4–3 shows the water quality in the perched zone in 1994. Groundwater quality in the perched aquifer has been affected by activities that have occurred over the past 40 years at Pantex. Since the perched aquifer is the shallowest water-bearing zone in the area, it is the first groundwater unit affected by migration of contaminants that were released from past industrial operations. These operations generated HE materials, organic solvents, and metals in liquid and solid waste. The direction and rates of contaminant movement of the perched aquifer are still under investigation, but are expected to be controlled by the location of buried channel deposits, direction and rate of groundwater movement, and source areas of historical contamination. Contaminants are believed to have reached the perched aquifer through historical vertical infiltration from ditches, landfills, and other past localized source areas. Downward migration of perched groundwater could potentially affect the groundwater quality of the underlying Ogallala Aquifer. However, no contamination from HE, organic compounds, or radionuclides has been detected in Ogallala wells onsite (PX DOE 1996b:4-77). In 1995, trace levels (less than 1 part per billion) of RDX were detected in wells tapping the upper portion of the Ogallala east of the plant.

Groundwater Availability, Use, and Rights. Five production wells in the northeast corner of Pantex serve the plant's industrial and potable water needs. During 1994, the plant pumped 836 million l (221 million gal) of

Table 3.5.4–3. Groundwater Quality Monitoring (Perched Zone Wells) at Pantex Plant, 1994

Contaminant	Unit of Measure	Water Quality Criteria and Standards[a]	Water Body Concentration High	Water Body Concentration Low
1,2-Dichloroethane	mg/l	0.005[b]	0.14	<0.005
Alpha (gross)	pCi/l	15[b]	11	<MDA[c]
Barium	mg/l	2.0[b]	0.25	0.047
Beta (gross)	pCi/l	50[d]	13	<MDA[c]
Chromium	mg/l	0.1[b]	1.95	<0.005
Copper	mg/l	1.0[e]	0.01	<0.005
HMX*	mg/l	NA	0.07	<0.02
Iron	mg/l	0.3[e]	3.55	<0.01
Lead	mg/l	0.015[b]	<0.005	<0.005
Nitrate	mg/l	10[b]	4.8	<0.01
pH	pH units	6.5-8.5[e]	9.0	6.7
RDX*	mg/l	NA	1.1	<0.020
Sulfate	mg/l	250[e]	56	12
Total dissolved solids	mg/l	500[e]	518	160
Total organic carbon	mg/l	NA	15	<1
Total organic halogens	mg/l	NA	259	<1
Trichloroethylene	mg/l	0.005[b]	0.15	<0.005
Tritium	pCi/l	80,000[f]	0.33	<MDA[c]
Uranium-234	pCi/l	20[f]	5.5	0.8
Uranium-238	pCi/l	24[f]	3.0	0.2
Zinc	mg/l	5.0[e]	0.684	<0.005

[a] For comparison purposes only.
[b] National Primary Drinking Water Regulations (40 CFR 141).
[c] Results were less than the MDA.
[d] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).
[e] National Secondary Drinking Water Regulations (40 CFR 143).
[f] DOE DCG for water (DOE Order 5400.5). DCG values are based on 100 mrem per year; however, because the drinking water maximum contaminant level is based on 4 mrem per year, the number listed is 4 percent of the DCG.

Note: The following wells were used to determine the contaminant range:
PM-19 (Perched Monitoring Northwest Playa One)
PM-20 (Perched Monitoring Zone 12 Sensor Bed)
PM-38 (Perched Monitoring Northeast Playa One)
PM-44 (Perched Monitoring Building 16-1)
PM-45 (Perched Monitoring Southeast Building 12-2)
PM-106 (Perched Monitoring Northeast Plant)
*=high explosive(s) compounds; NA=not applicable.

Source: PX DOE 1995d.

water from the Ogallala Aquifer, while the city of Amarillo pumped 23.9 billion l (6.3 billion gal) from its Carson County well field located north and northeast of the plant (PX DOE 1996b:4-77). The estimated sustainable groundwater producing capacity of the Ogallala is approximately 2 billion l/yr (0.528 billion gal/yr). Pantex Lake, located adjacent to the Amarillo water-well field, is available for drilling additional water wells if needed for future Pantex operations.

The Ogallala Formation is also a source of municipal and industrial water for nearby towns and cities and for irrigation water to nearby farms. In the Pantex area, the cities of Amarillo and Canyon maintain community water systems (see Figure 2.2.4–1 for regional map). The city of Amarillo draws its raw water from groundwater and Lake Meredith and has the capacity to supply 103,660 million l/yr (27,376 million gal/yr). The city of Canyon maintains the capacity to supply approximately 9,490 million l/yr (2,506 million gal/yr) from its own wells and may purchase up to 6,935 million l/yr (1,831 million gal/yr) from the city of Amarillo.

Groundwater is controlled by the individual landowner in Texas. The TNRCC and the Texas Water Development Board are the two State agencies with major involvement in groundwater fact finding, data gathering, and analysis. Groundwater management is the responsibility of local jurisdictions through Groundwater Management Districts. The Pantex facility is located in Panhandle Groundwater District 3, which has the authority to require permits and limit the quantity of water pumped. Presently, the Panhandle Groundwater District does not limit the quantity of water pumped.

3.5.5 GEOLOGY AND SOILS

Geology. Pantex is located on the Southern High Plains of the Texas Panhandle. The topography at Pantex consists of flat to gently rolling plains. There are no unique geologic landforms, and the only distinctive features are playas that are spaced more or less uniformly throughout the site. The playas are about 500 to 1,000 m (1,640 to 3,280 ft) across, with clay bottoms and depths to approximately 9 m (30 ft).

Pantex is underlain by the Blackwater Draw Formation which consists of a sequence of buried soils with an upper unit consisting of silt, clay, and caliche and a 12- to 23-m (39- to 76-ft thick) lower unit consisting of silty sand with caliche. The Ogallala Formation underlies the Blackwater Draw Formation and consists of interbedded sands, silts, clays, and gravels. The Ogallala Formation is underlain by the sedimentary rocks of the Dockum Group which are underlain by the Upper and Middle permian layers, which are composed predominantly of thick and widespread deposits of salt. The Lower Permian consists predominantly of complex accumulations of shale, limestone and argillaceous limestone, and dolomite. Some Permian formations of the Southern High Plains contain salt beds. The dissolution of these beds have resulted in sinkholes and fractures in nearby Armstrong and Hutchinson Counties, Texas. No sinkholes or fractures have been identified in Carson County. Recent work using shallow seismic data has determined that the structure beneath the playas on Pantex Plant and adjacent areas shows displacement of Ogallala strata. This displacement is attributed to the dissolution of underlying salt beds (PX DOE 1996b:4-31). No economically viable geologic resources have been identified at Pantex.

No capable faults as defined in 10 CFR 100, Appendix A, are present in the vicinity of Pantex. Three major subsurface faults and one minor surface fault occur near the Pantex site area (PX DOE 1995i:2-11). The longest fault, approximately 250 km (155 mi) long, is located about 40 km (25 mi) north of the site. A 70-km (43-mi) long fault is located about 8 km (5 mi) south of the site and a 64-km (40-mi) long fault is located about 11 km (7 mi) north of the site. The minor fault is surficial, about 6 km (4 mi) long, and located about 32 km (20 mi) northwest of the site.

Pantex lies on the boundary zone between Seismic Zones 0 and 1, indicating little or no damage could occur as a result of an earthquake (Figure 3.2.5–1). This area is relatively free from earthquakes. Twenty-five earthquakes with MMIs of VI (Table 3.2.5–1) have been recorded in the Texas Panhandle (PX DOE 1996b:4-33). There is no volcanic hazard at Pantex because there are no known areas of active volcanism in the Texas Panhandle.

Soils. Pantex is underlain by soils of the Pullman-Randall association. The Pullman-Randall soil association consists of nearly level to gently sloping deep noncalcareous clays and clay loams. Pullman soils underlie most of the Pantex area, but Randall soils occur in the vicinity of the playas and depressions. Water and wind erosion and shrink-swell potential are moderate to high for most of the soil units (PX USDA 1962a:2,9-15; PX USDA 1980a:32). However, the soils at Pantex are acceptable for standard construction techniques.

3.5.6 BIOLOGICAL RESOURCES

Terrestrial Resources. Pantex is located within a treeless portion of the High Plains that is classified as mixed prairie. The High Plains vegetational area is a southern extension of the short- and mid-grass prairies of the Western Great Plains. The primary vegetation of the High Plains includes short-grasses (that is, buffalo-grass and blue grama) and mid-grasses (that is, little bluestem, sideoats grama, and western wheatgrass) (PX DOE 1991a:2). Approximately 25 percent of the site, including land leased from Texas Tech University, has been developed (PX 1992a:5). Much of the remainder of the site is currently being managed as native and improved pasture or cultivated by the University or its tenant farmers (PX DOE 1983a:3-20,3-23). Small areas of relatively undisturbed vegetation exist around playas. Some protection for native habitat is also provided where plant operations preclude agricultural activities. Vegetation within these areas is primarily grasses and herbs, although barrel cactus is also present (PX DOE 1995d:5-3,5-4). A site vegetation map is not available (PX 1992a:6). While the area proposed for storage facilities has been largely disturbed by past activities, the assumed analysis site for the evolutionary LWR is in agricultural use. A total of 229 plant species have been identified on the Pantex Site (PX DOE 1993c:2).

Terrestrial wildlife species occurring on Pantex include 7 amphibian, 8 reptile, 43 bird, and 19 mammal species (PX DOE 1994c:4,5; PX DOE 1994d:7-11). Common bird species known to occur in the vicinity of Pantex include the western meadowlark, mourning dove, horned lark, and several species of sparrows. Common species of mammals found in the vicinity of Pantex include the black-tailed jackrabbit, black-tailed prairie dog, and hispid cotton rat (PX 1994a:1; PX DOE 1991a:2). Among the game animals occurring onsite are the desert cottontail, northern bobwhite, scaled quail, mourning dove, and numerous waterfowl species (PX 1994a:1). Hunting is not permitted at Pantex (PX 1992a:5). Common raptors on Pantex include the Swainson hawk, American kestrel, and burrowing owl (PX DOE 1994b:3,5). Carnivores present include the badger and coyote. A variety of migratory birds has been found at Pantex. Migratory birds, as well as their nests and eggs are protected by the *Migratory Bird Treaty Act*. Eagles are similarly protected by the *Bald and Golden Eagle Protection Act*.

Wetlands. Wetlands at Pantex are associated with the five playa basins occurring on the site, and Pantex Lake (also a playa), located approximately 5 km (3 mi) northeast of the site. The NWI map identifies Playas 1 through 5 and part of Pantex Lake as wetlands. Playas 1, 2, and 3 are classified by the USFWS as palustrine systems. The larger Playas, 4 and 5, and most of Pantex Lake are classified as lacustrine systems. Playas 1, 2, and 4 currently receive stormwater discharge. There are numerous smaller wetlands (approximately 4 ha [10 acres] or less) located on western and southwestern parts of Pantex in areas that are largely grazed or farmed (PX 1992a:4). While these wetlands have not been delineated using COE criteria (USCOE 1987a:13-14), they are classified on NWI maps as palustrine systems. Situated along the central flyway migratory route, the Pantex playas are important to migratory birds and also provide valuable habitat for nesting and wintering species. While the consolidated Pu storage facility site does not contain any of the smaller wetlands noted above, the assumed analysis site for the evolutionary LWR could contain one such wetland.

Aquatic Resources. Aquatic habitat at Pantex is limited to five ephemeral playas (including Pantex Lake), one permanent playa, and several ponds and ditches. Although the playas and ditches may provide habitat for amphibians and macroinvertebrates, they do not support any fish populations (PX 1992a:5), except for a small pond at the southeast corner of Pantex Lake, which supports a population of minnows (PX DOE 1996b:4-139). Aquatic resources do not occur on the consolidated Pu storage facility site or the assumed analysis site for the evolutionary LWR.

Threatened and Endangered Species. Ten federally or State-listed threatened, endangered, and other special status species may be found on or in the vicinity of Pantex; eight of these are federally or State-listed as threatened or endangered (Table 3.5.6–1). Five species listed in Table 3.5.6–1 have been observed on Pantex, including four of the federally or State-listed threatened or endangered species. Once specific project locations have been determined, site surveys will verify the presence of special status species. The discussion presented

Table 3.5.6–1. Federally and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found on or in the Vicinity of Pantex Plant

Common Name	Scientific Name	Status[a] Federal	Status[a] State
Mammals			
[Text deleted.]			
Swift fox[b]	*Vulpes velox*	C	NL
[Text deleted.]			
Birds			
American peregrine falcon[c]	*Falco peregrinus anatum*	E	E
Arctic peregrine falcon	*Falco peregrinus tundrius*	E (S/A)	T
Bald eagle[b,c]	*Haliaeetus leucocephalus*	T	E
[Text deleted.]			
Interior least tern[c]	*Sterna antillarum athalassos*	E	E
[Text deleted.]			
Mountain plover	*Charadrius montanus*	C	NL
[Text deleted.]			
White-faced ibis[b]	*Plegadis chihi*	NL	T
Whooping crane[b,c]	*Grus americana*	E	E
Reptiles			
Smooth green snake	*Opheodrys vernalis*	NL	E
[Text deleted.]			
Texas horned lizard[b]	*Phrynosoma cornutum*	NL	T

[a] Status codes: C=Federal candidate; E=endangered; NL=not listed; S/A=protected under the similarity of appearance provision of the ESA; T=threatened.

[b] Species observed on the Pantex Plant site.

[c] USFWS Recovery Plan exists for this species.

Source: 50 CFR 17.11; 50 CFR 17.12; 61 FR 7596; PX DOE 1996b; PX MH 1994c; TX PWD 1993a; TX PWD 1995a; TX PWD 1995b.

in this section is generally applicable to Pantex as a whole. No critical habitat for threatened and endangered species, as defined in the ESA (50 CFR 17.11; 50 CFR 17.12), exists on Pantex.

The bald eagle is a winter resident that has been observed foraging at playas on the site each year. Prairie dog towns provide feeding habitat for bald eagles and other raptors. The whooping crane, an infrequent migrant in the Texas Panhandle, was observed foraging onsite and in the surrounding area in the fall of 1990 (PX 1992a:3). Migratory peregrine falcons (undetermined subspecies) have been observed hunting shorebirds and waterfowl near area playas (PX WTS 1992a:1). [Text deleted.] Possible swift fox dens have been found on Pantex. The Texas horned lizard is known to reside on the site. [Text deleted.] White-faced ibis forage at the playas.

There is little undisturbed habitat at Pantex that would accommodate any of the threatened, endangered, and other special status species, other than the Texas horned lizard, listed in Table 3.5.6–1. Most of these species are attracted to the playas, which provide water and foraging habitat. No federally or State-listed plant species are known to occur on Pantex. However, there are three cactus species at Pantex that may be proposed for a watchlist of potentially threatened plant species (PX DOE 1993c:15-16).

3.5.7 CULTURAL AND PALEONTOLOGICAL RESOURCES

Prehistoric Resources. Prehistoric site types identified at Pantex include small temporary campsites and limited activity locations characterized by surface scatters of artifacts. Archaeological surveys at Pantex have systematically covered approximately one-half of the facility. Approximately 60 prehistoric sites have been recorded to date on DOE and Texas Tech University property. Some of the sites contain heat-altered rock and artifact types that suggests food processing. These prehistoric campsites tend to be clustered near the Pantex playa drainages. Of 23 archaeological sites tested, only one has been determined potentially eligible for listing on the NRHP. It is a late prehistoric bison kill or butchering site north of Pantex Lake. Some areas where the facilities would be located have not been systematically surveyed for prehistoric resources. However, a site location model has been developed and tested at Pantex, and indicates it is highly unlikely that such sites are present. In this model, prehistoric sites would be located only within 0.4 km (0.25 mi) of playas or their obvious drainages. A Programmatic Agreement to ensure regulatory compliance at Pantex will be in place by fiscal year 1997, and a cultural resource management plan is being developed. Implementation of this plan, which will supersede the Programmatic Agreement, is scheduled for 1998. An interim programmatic agreement is in place to ensure regulatory compliance, and potential impacts are evaluated on a case-by-case basis.

Historic Resources. The Pantex facility was originally constructed in 1942 as a World War II bomb-loading plant on land claimed from local farmers. To date, 12 historic archaeological sites associated with these original farmsteads have been located and recorded. These sites have minimal integrity and are highly unlikely to be eligible for the NRHP. All of Pantex has been surveyed for World War II-era structures and foundations, and all such properties have been systematically recorded. Based on information gathered during surveys, Zone 4, originally constructed as a High Explosive Storage Area for ammonium nitrate, does not appear to possess the architectural integrity necessary to be eligible for the NRHP. The Texas SHPO prepared a list of 45 buildings in Zones 11 and 12 that may be eligible for NRHP listing. The Cold War historic context has not yet been fully defined for Pantex. When completed, it is probable that a number of plant structures will be determined NRHP eligible.

Native American Resources. Native Americans known to have potential interests in Pantex include the Comanche Tribe of Oklahoma; the Kiowa Tribe of Oklahoma; the Apache Tribe of Oklahoma; the Cheyenne-Arapaho Tribe of Oklahoma; the Wichita and Affiliated Tribes; the Caddo Tribe of Oklahoma; the Delaware Tribe of Western Oklahoma; and the Fort Sill Apache Tribe. Four of these tribes, the Fort Sill Apache Tribe, the Apache Tribe of Oklahoma, the Kiowa Tribe of Oklahoma, and the Comanche Tribe of Oklahoma, have recognized traditional interests in Pantex. DOE is performing a historic treaties search and a public outreach program to involve Native American stakeholders in decisionmaking related to the use of Pantex land and the protection of cultural resources. Traditional cultural properties have not been identified at Pantex, but the remains of temporary historic campsites and hunting locations are possible.

Paleontological Resources. The surficial geology of the Pantex area consists of silts, clays, and sands of the Blackwater Draw Formation. In other areas of the High Plains, this formation contains Late Pleistocene vertebrate remains, including bison, camel, horse, mammoth, and mastodon, with occasional evidence of their use by humans. [Text deleted.]

3.5.8 SOCIOECONOMICS

Socioeconomic characteristics described for Pantex include employment, regional economy, population, housing, community services, and local transportation. Statistics for employment and regional economy are presented for the REA, which encompasses 32 counties surrounding Pantex in Texas and New Mexico (Table L.1–1). Statistics for population, housing, community services, and local transportation are presented for the ROI, a four-county area in which 95.8 percent of all Pantex employees reside: Armstrong County (1.4 percent), Carson County (5.4 percent), Potter County (34.4 percent), and Randall County (54.6 percent) (Table L.1–5). In 1994, Pantex employed 3,559 persons (1.8 percent of the total REA employment).

Regional Economy Characteristics. Selected employment and regional economy statistics for the Pantex REA are summarized in Figure 3.5.8–1. Between 1980 and 1990, the civilian labor force increased 9.3 percent to 209,786. In 1994, the unemployment rate in the REA was 4.8 percent, lower than 6.4 percent unemployment in Texas and 6.3 percent unemployment in New Mexico. The 1993 per capita income in the REA was $19,312, higher than the per capita income in both Texas ($19,145) and New Mexico ($16,346).

Employment patterns in the REA closely parallel those in Texas and New Mexico, with manufacturing, retail trade, and service providing the majority jobs. The service sector accounts for the largest percentage of employment in both Texas and New Mexico, 27.7 percent and 28.3 percent, respectively, as well as in the region, 22.1 percent.

Population and Housing. Population and housing trends in the Pantex ROI are summarized in Figure 3.5.8–2. The ROI population, which totaled 205,684 in 1994, grew 12.8 percent between 1980 and 1994, less than half the growth rate of Texas (29.2 percent) during the same period. Within the ROI, the population of Carson County fell by 1.5 percent, while Randall County's grew 25.4 percent.

The increase in the total number of housing units in the ROI between 1980 and 1990 was approximately 11 percent, less than half the 26.3-percent increase in Texas. In Randall County, however, the number of housing units increased 28.3 percent during the same period. In 1990, homeowner and rental vacancy rates in the Pantex ROI were similar to those in Texas, approximately 3 percent and 14 percent, respectively.

Community Services. Community services described for the Pantex ROI are education, public safety, and health care. Figure 3.5.8–3 presents school district characteristics for the Pantex ROI, and Figure 3.5.8–4 presents public safety and health care characteristics.

Education. In 1994, the nine school districts that provided public education services and facilities in the Pantex ROI ranged in enrollment size from 229 students in the Groom School District to 28,925 students in the Amarillo School District. As shown in Figure 3.5.8–3, school districts were operating between 63.5 and 99.7 percent of capacity. The average student-to-teacher ratio for the ROI was 16.3:1.

Public Safety. Six city and county law enforcement agencies provide police protection in the ROI. In 1994, the city of Amarillo maintained the largest police force in the ROI, with 253 officers. The average ROI officer-to-population ratio was 2.3 officers per 1,000 persons. Figure 3.5.8–4 displays the sworn police officer-to-population ratios for the ROI counties and cities.

Ten fire departments consisting of a total of 491 regular and volunteer firefighters provided fire protection services in 1995. The city of Amarillo had the largest department in the ROI, with 213 paid firefighters. The highest firefighter-to-population ratio was 19.0 firefighters per 1,000 persons in Armstrong County. The average ROI firefighter-to-population ratio was 2.3 firefighter per 1,000 persons.

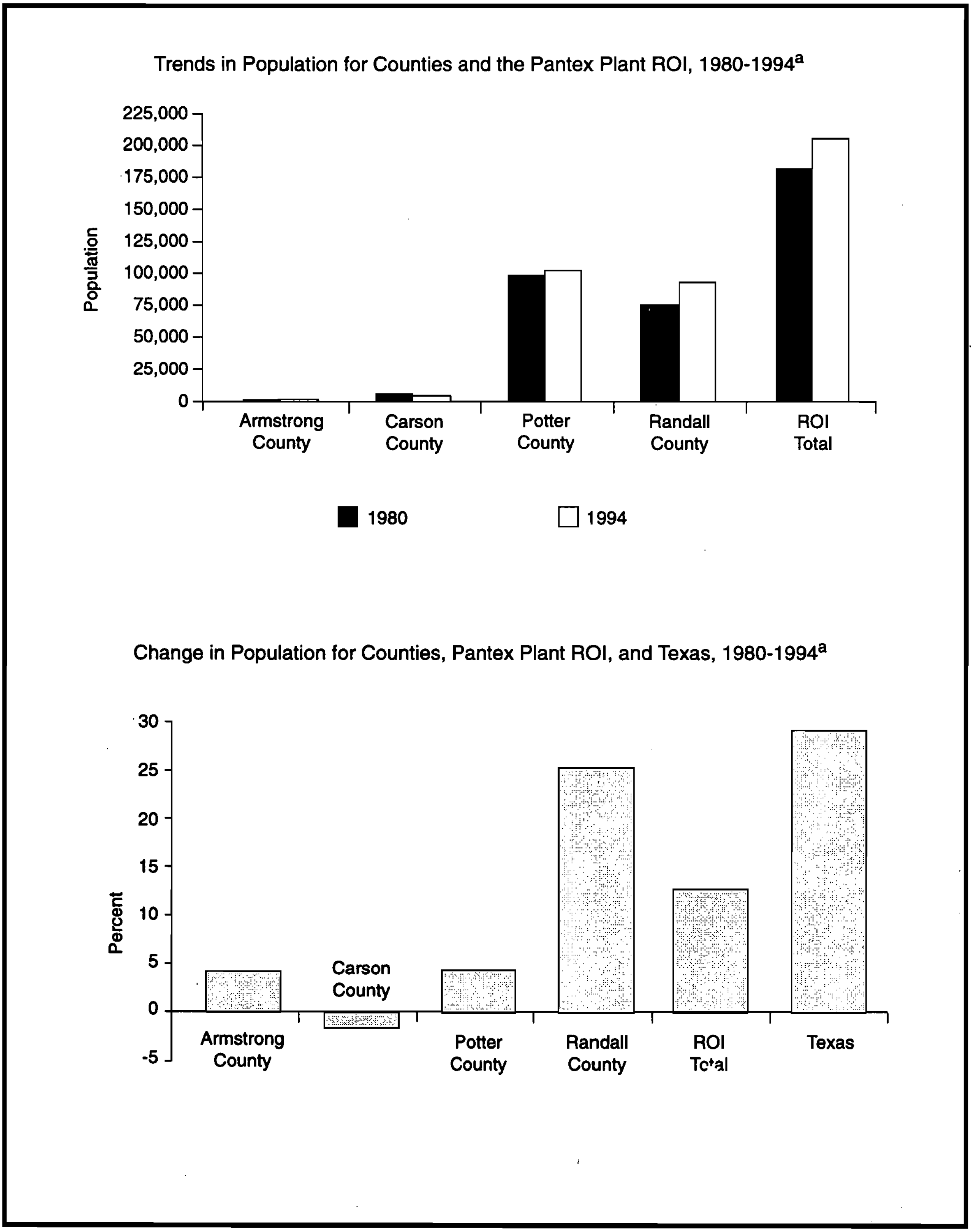
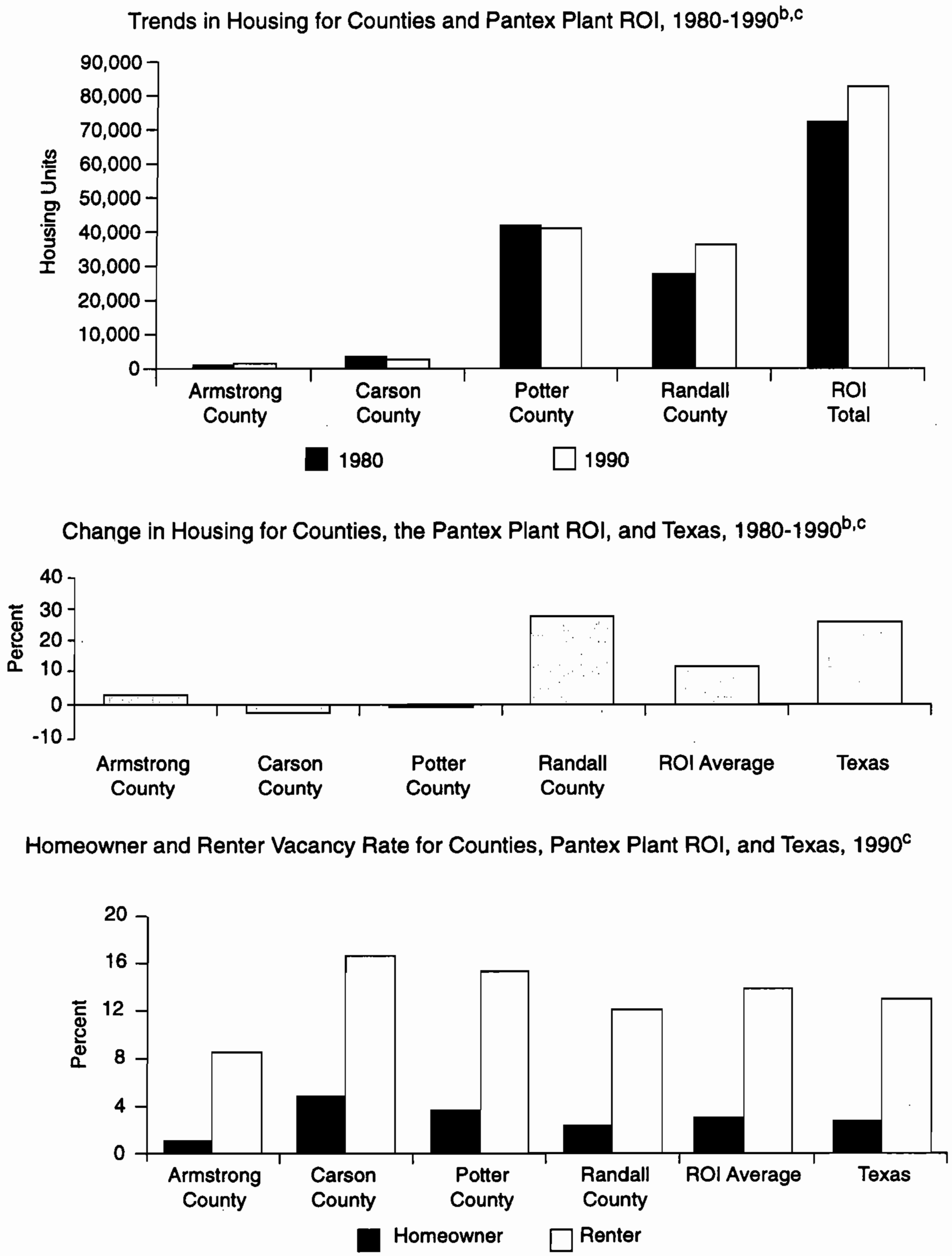
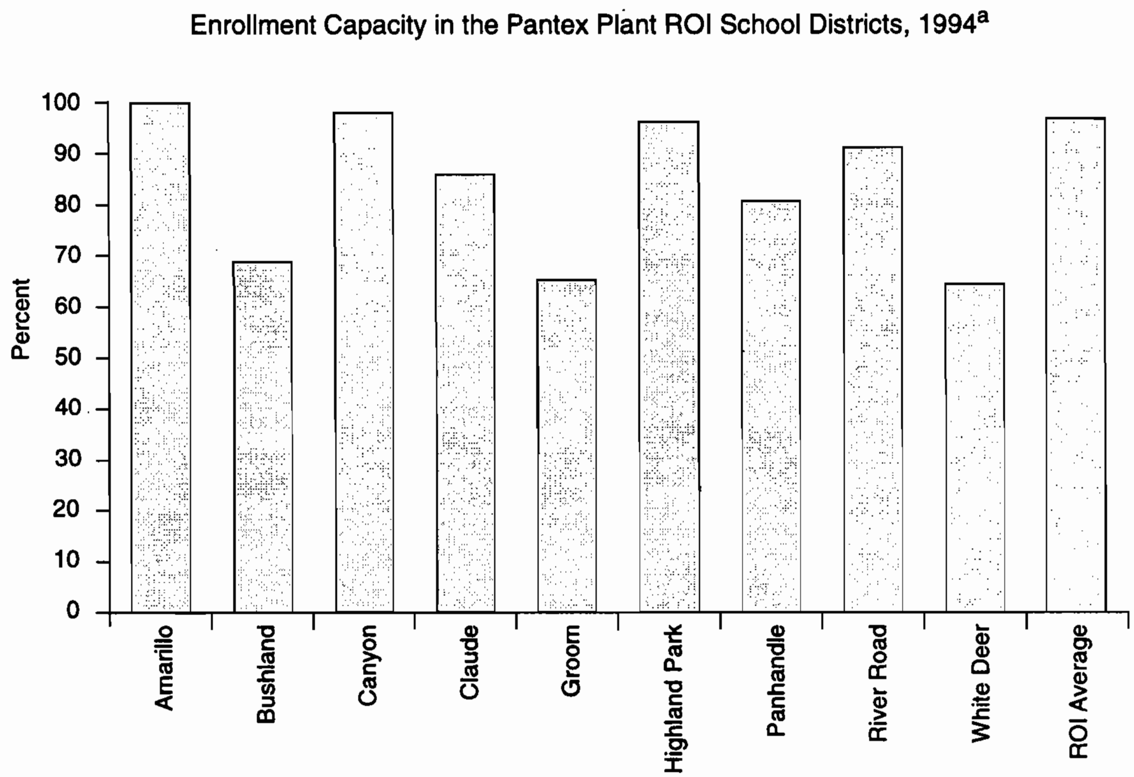


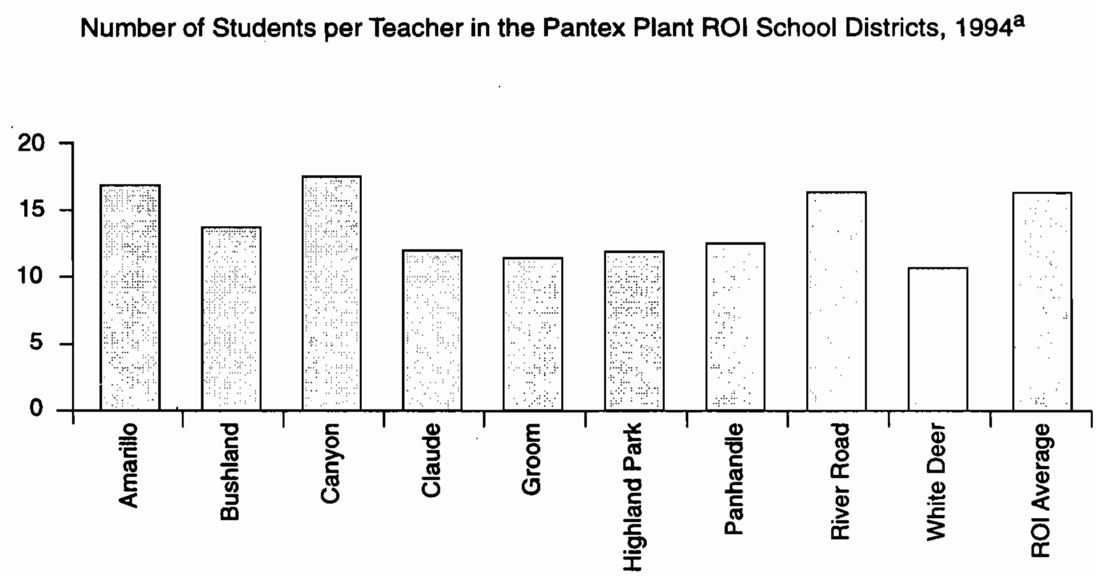
Figure 3.5.8–2. Population and Housing for the Pantex Plant Region of Influence and the State of Texas.



[a] Census 1994o; Census 1995a
[b]Census 1982a.
[c]Census 1991m.

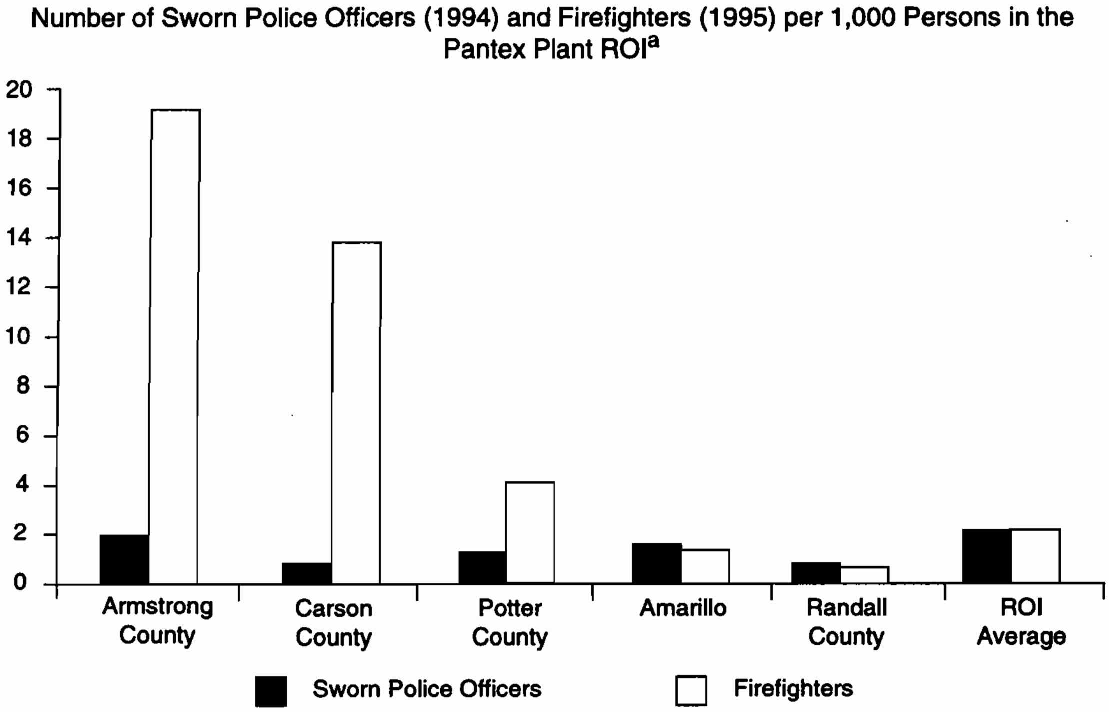
Figure 3.5.8–2. Population and Housing for the Pantex Plant Region of Influence and the State of Texas—Continued.



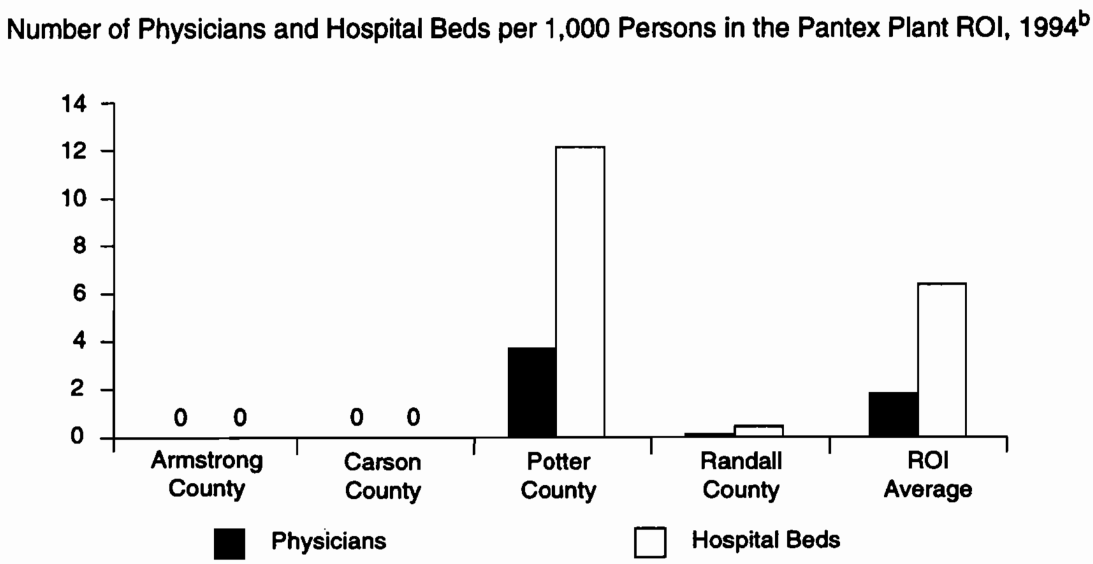


[a]Socio 1996a.

Figure 3.5.8–3. School District Characteristics for the Pantex Plant Region of Influence.



Note: Non-ROI city values are included in county totals. Amarillo police and firefighters serve both Potter and Randall Counties.



[a] Census 1995a; DOC 1996a; DOC 1996b; DOJ 1995a; Socio 1996a.
[b] AHA 1995a; AMA 1995a; Census 1995a.

Figure 3.5.8–4. Public Safety and Health Care Characteristics for the Pantex Plant Region of Influence.

Health Care. Six hospitals serve the four-county ROI, all operating well below capacity. The highest hospital bed-to-population ratio was 12.3 beds per 1,000 persons in Potter County. There are no hospitals in Armstrong or Carson Counties; medical emergencies in these counties are customarily transported to the cities of Amarillo or Pampa via ambulance service. In 1994, a total of 407 physicians served the ROI. Figure 3.5.8–4 shows that the highest physician-to-population ratio was 3.8 physicians per 1,000 persons in Potter County while there were no physicians in Carson and Armstrong Counties. The average physician-to-population ratio in the ROI was 2.0 physicians per 1,000 persons.

Local Transportation. Vehicular access to Pantex is provided by Farm-to-Market Roads 683 to the west and 2373 to the east. Both roads connect with Farm-to-Market Road 293 to the north and U.S. Highway 60 to the south. No major improvements are scheduled or currently ongoing for roads providing immediate access to Pantex (see Figure 2.2.4-1 and Figure 2.2.4-2).

Four road segments in the ROI could be affected by the storage and disposition alternatives. The first is I-27 from Local Route 335 at Amarillo to I-40 at Amarillo. This segment operated at level of service A in 1995. The second is Farm-to-Market Route 683 from U.S. 60 to Farm-to-Market Route 293. This segment operated at level of service A in 1995. The third is Farm-to-Market Route 2373 from I-40 to U.S. 60. This segment operated at level of service A in 1995. The fourth is Farm-to-Market Route 2373 from U.S. 60 to Farm-to-Market Route U.S. 60. The segment operated at level of service A in 1995.

Amarillo City Transit provides public transport service to Amarillo, but the service does not extend to Pantex. The major railroad in the Pantex ROI is the Burlington Northern and Santa Fe Railroad, a mainline which forms the southern boundary of Pantex and provides direct access to the site. There are no navigable waterways within the ROI capable of accommodating material transports to the plant.

Amarillo International Airport provides jet air passenger and cargo service from national and local carriers. Several smaller private airports are located throughout the ROI.

3.6 OAK RIDGE RESERVATION

The ORR is located in Oak Ridge, Tennessee (Figure 2.2.5–1), and contains ORNL, Y–12, and the K–25 Site. The primary focus of ORNL is conducting basic and applied scientific research and technology development. Y–12 engages in national security activities and manufacturing outreach to U.S. industries. K–25 serves as an operations center for ORR's environmental restoration and waste management programs. The locations of facilities within ORR are illustrated in Figure 2.2.5–2.

Department of Energy Activities. These activities can be categorized as defense programs, environmental management, and other DOE missions. The current missions and functions at ORR are described in Table 3.6–1.

The ORR DP assignments are performed at Y–12 and include storing uranium and lithium materials and weapons parts, maintaining the capability to fabricate components for nuclear weapons, dismantling nuclear weapon components returned from the national stockpile, processing special nuclear materials, and providing special production support to the DOE design agencies and other DOE programs.

Table 3.6–1. Current Missions at Oak Ridge Reservation

Mission	Description	Sponsor
Uranium and lithium storage	Store enriched uranium, depleted uranium, and lithium materials and parts	Assistant Secretary for Defense Programs
Weapons components	Maintain capability to fabricate uranium and lithium components and parts for nuclear weapons	Assistant Secretary for Defense Programs
Dismantlement activities	Dismantle nuclear weapon components returned from the stockpile	Assistant Secretary for Defense Programs
Special nuclear material	Process uranium	Assistant Secretary for Defense Programs
Support services	Provide support to design agencies	Assistant Secretary for Defense Programs
Environmental restoration and waste management	Waste management and D&D activities at ORNL, Y–12, and K–25	Assistant Secretary for Environmental Management
Research and development	ORNL basic research and development in energy, health, and environment	Office of Energy Research; Assistant Secretary for Environment, Safety and Health; Office of Nuclear Energy
Isotope production	ORNL produces radioactive and stable isotopes not available elsewhere	Office of Nuclear Energy
Educational and research programs	Oak Ridge Institute for Science and Education programs in the areas of health, environment, and energy	Office of Energy Research; Assistant Secretary for Environment, Safety and Health; Office of Nuclear Energy
Work for other Federal agencies	Meteorological, reactor safety, environmental research	NOAA, NRC, EPA
Technology transfer	Programs to transfer unique technologies developed at ORR to private industry	Department of Energy

Source: OR LMES 1995e; OR DOE 1994c.

The Y–12 Plant was constructed as part of the World War II Manhattan Project. The site's first mission was the separation of U-235 from natural uranium by electromagnetic separation. The magnetic separators were taken out of commission at the end of 1946, when gaseous diffusion became the accepted process for enriching uranium. Missions have evolved and changed with the end of the Cold War resulting in a reduction of Y–12's weapon component production mission. Due to the reduced workloads, the operational space at Y–12 is being significantly downsized. However, since Y–12 is designated as the interim DOE repository for unirradiated enriched uranium, the present interim storage space is being expanded in existing facilities to accommodate additional enriched uranium returned from stockpiled weapons and other DOE sites. The majority of this HEU would be housed in facilities currently utilized for HEU storage. The remaining HEU would be stored in facilities currently being converted into storage areas. This expansion of the plant's storage capacity is an ongoing DOE-approved effort to prepare Y–12 for the large quantity of HEU arriving over the next few years.

The Y–12 Plant continues to maintain the capability to fabricate nuclear weapon components as a major mission. Maintaining production capability involves the ability to fabricate materials into components, inspect and certify the components, and produce weapons subassemblies from the components.

As nuclear weapons are removed from the stockpile, they must be dismantled, and materials and parts appropriately dispositioned. These returned materials and components, as well as those currently located at Y–12, are safely and securely placed in interim storage.

The Y–12 Plant also provides fabrication support to DOE's weapon design laboratories at LANL, LLNL, and Sandia National Laboratories (SNL), and produces components design evaluations for these customers. In addition, Y–12 performs some stockpile surveillance activities to ensure reliability of the nuclear stockpile.

Environmental management activities are in progress at each of the major facilities within ORR. These activities consist of environmental remediation and restoration, D&D of surplus facilities, and waste management. DOE's Center for Environmental Technology and Center for Waste Management are located at K–25. Environmental restoration and waste management activities at ORR are discussed in detail in Section 3.6.10 and Appendix E.

Oak Ridge Reservation, in conjunction with the Oak Ridge Institute for Science and Education, supports other offices and missions within DOE (Energy Research, ES&H, Nuclear Energy).

Non-Department of Energy Activities. Non-DOE activities pursued at ORR include missions and programs of the NOAA, which conducts meteorological and atmospheric diffusion research that is supported by itself and DOE. This work is done at the Atmospheric Turbulence and Diffusion Laboratory and field sites on ORR. This laboratory also provides services to DOE contractors and operates the Weather Instrument Telemetering Monitoring System for DOE. In addition, ORR provides support to other Federal agencies (NRC, EPA, and others), and private industry in conducting basic scientific research; engineering technology development and transfer; and educational research in the areas of health, environment, and energy.

3.6.1 LAND RESOURCES

Land Use. The ORR consists of approximately 13,980 ha (34,500 acres) located mostly within the corporate limits of the city of Oak Ridge, approximately 19 km (12 mi) west of Knoxville, Tennessee. All the land within ORR is owned by the Federal Government and is administered, managed, and controlled by DOE. One alternative proposes to site a new facility on a section of land located on undeveloped land south of Bear Creek Road along the Clinch River. The potential site is not within the ORR boundary, but it is owned by the TVA.

Existing Land Use. Generalized land uses at ORR and in the vicinity are shown in Figure 3.6.1–1. Land uses within ORR can be grouped into four classifications: industrial, forest/undeveloped, public/quasi-public, and water. The industrial areas account for approximately 4,700 ha (11,600 acres) of the total site acreage. About 500 ha (1,240 acres) are used for a security buffer zone around various facilities. About 300 ha (741 acres) of ORR's land is classified as public land and consists mainly of the 36-ha (89-acre) Clark Center Recreational Park, numerous small public cemeteries, and an onsite public road (OR DOE 1989a:5-10). The remaining area, about 8,500 ha (21,000 acres), consists of forest/undeveloped land, some of which is managed as pine plantations for production of pulpwood and saw timber. The DOE water treatment facility, which provides water to many ORR facilities and the city of Oak Ridge, is located just north of Y–12. There are no prime farmlands on ORR.

In 1980, DOE designated a portion of ORR's undeveloped land as a NERP. As of July 1994, the NERP consisted of segments totalling 5,008 ha (12,375 acres) spread over ORR. The NERP is used by the national scientific community as an outdoor laboratory for environmental science research on the impact of human activities on the eastern deciduous forest ecosystem (DOE 1994u:37,51).

Land bordering ORR is predominantly rural and used largely for residences, small farms, forest land, and pasture land. The city of Oak Ridge, adjacent to the northeast portion of ORR, has a typical urban mix of residential, public, commercial, and industrial land uses. There are four residential areas along the northern boundary of ORR; each has several houses within 30 m (98 ft) of the site boundary.

Land-Use Planning. The ORR has other facilities planned. Proposed short-range projects (1995 through 1999) include the Composite Materials Laboratory, Center for Biological Sciences, Mixed Waste Treatment Facility, Recycle and Materials Processing Facility, Process Waste Treatment Facility, Industrial Landfill Expansion and Upgrades, and Steam Plant Waste Water Treatment Facility. Figure 3.6.1–2 shows potential facility areas in relation to existing ORR facilities.

The majority of ORR lies within the city of Oak Ridge. A small portion of the northwest corner of ORR lies outside the city, in Roane County. The Oak Ridge Area Land Use Plan (city of Oak Ridge) designates ORR with the following land uses: residential, office/institutional, industrial, public, and undesignated (OR City 1995a:1). The city of Oak Ridge zoning ordinance classifies the entire ORR as Forest, Agriculture, Industry, and Research District (OR City 1995a:2). The Roane County zoning ordinance does not classify ORR lands, rather, it identifies ORR as a DOE Reservation (OR City 1995a:3).

Visual Resources. The ORR landscape is characterized by a series of ridges and valleys that trend in a northeast-to-southwest direction. The vegetation is dominated by deciduous forest mixed with some coniferous forest. Much of ORR's open field area (about 2,000 ha [4,940 acres]) has been planted in shortleaf and loblolly pine; smaller areas have been planted in a variety of deciduous and coniferous trees (OR DOE 1989a:3-14). The DOE facilities are brightly lit at night, making them especially visible. The developed areas of ORR are consistent with BLM's VRM Class 5 designation. The remainder of ORR ranges from a VRM Class 3 to Class 4 designation.

The viewshed consists mainly of rural land. The city of Oak Ridge is the only adjoining urban area. Sensitive viewpoints affected by DOE facilities are primarily associated with Interstate 40, State Highway 62, 95, and 58;

and Bethel Valley and Bear Creek Roads. The Clinch River/Melton Hill Lake, and the bluffs on the opposite side of the Clinch River also have views of ORR, but views of most of the existing DOE facilities are blocked by terrain and/or vegetation. Although only a small portion of State Highways 62 crosses ORR, it is a major route for traffic to and from Knoxville and other communities (OR DOE 1989a:3-29). Views are limited by the hilly terrain, heavy vegetation, and generally hazy atmospheric conditions. Partial views of the DOE water treatment plant facilities can be seen from the urban areas of the city of Oak Ridge.

3.6.2 SITE INFRASTRUCTURE

Baseline Characteristics. To support ORR missions, an extensive infrastructure exists, as shown in Table 3.6.2–1.

Table 3.6.2–1. Oak Ridge Reservation Baseline Characteristics

Characteristics	Current Usage	Site Availability
Transportation		
Roads (km)	71	71
Railroads (km)	27	27
Electrical		
Energy consumption (MWh/yr)	726,000	13,880,000
Peak load (MWe)	110	2,100
Fuel		
Natural gas (m^3/yr)	95,000,000	250,760,000
Oil (l/yr)	416,000	416,000[a]
Coal (t/yr)	16,300	16,300[a]
Steam (kg/hr)	150,000	150,000

[a] Oil and coal availability is unlimited, figures are for current use.
Source: OR LMES 1996i; OR DOE 1994c.

Oak Ridge Reservation is served by three major highways, the mainline of two railroads, a regional airport, and a barge facility on the Inland Waterway system. A well-maintained system of interstate, regional, and local highways supports the onsite road network of approximately 71 km (44 mi) of roadway. Rail spurs connect onsite facilities to national lines of the Norfolk Southern and CSX Transport systems. There are 27 km (17 mi) of onsite rail to service operations at ORNL, Y–12, and K–25. Existing barge facilities on the Clinch River, adjacent to State Route 58, provide access to the Inland (Tennessee-Tombigbee) Waterway system via the Tennessee River to ports ranging from the Great Lakes to the Gulf of Mexico.

Numerous high-voltage transmission lines from the TVA power systems supply electric power to major plants on ORR. Transmission lines serving other areas also cross the site. Current energy consumption is 726 gigawatt-hours/yr, with a peak load of 110 MWe. The current load capacity at ORR is 805 MWe. The current reserve capacity is 1,295 MWe. A 56-cm (22-in) main from East Tennessee Natural Gas in Knoxville is available onsite. The current quantity of natural gas furnished to ORR upon demand is limited to 0.687 million m^3/day (24.3 million ft^3/day), with 0.42 million m^3/day (14.8 million ft^3/day) interruptible upon a 4-hour notice. The current natural gas consumption is approximately 95 million m^3/yr (3,350 million ft^3/yr). Oil and coal availability is unlimited, with current consumption of 416,000 l/yr (110,000 gal/yr) of oil and 16,300 t/yr (18,000 tons/yr), respectively. Steam is used and generated at approximately 150,000 kg/hr (330,000 lb/hr).

Oak Ridge Reservation is located in the Southeastern Electric Reliability Council regional power pool and draws its power from the TVA Subregion. Characteristics of this power pool are given in Table 3.6.2–2. The total system generation capacity is 33,370 MWe, with a peak demand of 28,127 MWe. The mix of fuels utilized in generating this power pool requirement is predominantly coal and nuclear with 49 and 39 percent, respectively, followed by hydroelectric power generation at 11 percent. Less than 1 percent of the electrical generation requirements is produced using oil and natural gas. TVA is typically a net exporter of power, with approximately 2.4 million megawatt-hours (MWh) exported annually.

Eight facilities at Y–12 are currently used to store enriched uranium or process it for storage. These facilities would continue to be used for the interim storage of HEU as described in the Y–12 EA. The buildings are all located within the existing controlled and secured protected area of Y–12. Buildings 9204-2, 9204-2E, and

Table 3.6.2–2. Tennessee Valley Authority Sub-Regional Power Pool Electrical Summary

Characteristics	Energy Production
Type Fuel[a]	
Coal	49%
Nuclear	39%
Hydro/geothermal	11%
Oil/gas	<1%
Other	0%
Total Annual Production	159,842,000 MWh
Total Annual Load	156,987,000 MWh
Energy Exported Annually[b]	2,407,000 MWh
Generating Capacity	31,840 MWe
Peak Demand	28,127 MWe
Capacity Margin[c]	4,550 MWe

[a] Percentages do not total 100 percent due to rounding.

[b] Energy exported is not the difference of production and load due to negative net pumped storage.

[c] Capacity margin is the amount of generating capacity available to provide for scheduled maintenance, emergency outages, system operating requirements, and unforeseen electrical demand.

Source: NERC 1993a.

9204-4, located in the western portion of Y–12, are all large, multistory, industrial-type buildings that have been modified several times since their construction. Building 9204-2 is approximately 25,100 m^2 (270,000 ft^2), Building 9204-2E is approximately 14,100 m^2 (151,000 ft^2), and Building 9204-4 is approximately 25,400 m^2 (274,000 ft^2). Building 9206, centrally located within Y–12, is a 4,000 m^2 (43,000 ft^2) structure with a 1,900 m^2 (20,000 ft^2) second story in its central portion. Building 9212, centrally located within Y–12, is a multistory facility that spans approximately 9,300 m^2 (100,000 ft^2). Building 9215 is an approximately 11,800 m^2 (127,000 ft^2) two-story structure that is centrally located within Y–12. Building 9720-5 is a single-story warehouse that includes approximately 3,700 m^2 (40,000 ft^2) of storage space. This facility is the principal storage location for HEU as described in the Y–12 EA. Building 9998 is a multifloor structure with approximately 2,260 m^2 (24,000 ft^2). Buildings 9998 and 9215 are integrally connected and may be considered as a single-building complex. Buildings other than these eight may be modified for the interim storage of HEU as described in the Y–12 EA.

3.6.3 AIR QUALITY AND NOISE

Meteorology and Climatology. The Cumberland and Great Smoky Mountains have a moderating influence on the climate at ORR. Winters are generally mild and summers warm, with no noticeable extremes in precipitation, temperature, or winds.

The average annual temperature at ORR is 13.7 °C (56.6 °F); temperatures vary from an average daily minimum of -3.8 °C (25.1 °F) in January to an average daily maximum of 30.4 °C (86.7 °F) in July. The average annual precipitation is approximately 136.6 cm (53.77 in). Prevailing wind directions at ORR tend to follow the orientation of the valley: upvalley, from west to southwest, or downvalley, from east to northeast. The average annual windspeed is approximately 2.0 m/s (4.4 mph) (NOAA 1994c:3). Additional information related to meteorology and climatology at ORR is presented in Appendix F.

Ambient Air Quality. The ORR is located in Anderson and Roane Counties in the eastern Tennessee and southwestern Virginia Interstate AQCR (#207). As of 1995, the areas within this AQCR were designated by EPA as in attainment (40 CFR 81.343) with respect to the NAAQS for criteria pollutants (40 CFR 50). Applicable NAAQS and Tennessee State ambient air quality standards are presented in Appendix F.

One PSD (40 CFR 52.21) Class I area can be found in the vicinity of ORR. This area, the Great Smoky Mountains National Park, is located approximately 48.3 km (30 mi) southeast of ORR. Since the creation of the PSD program in 1977, no PSD permits have been required for any emission source at ORR.

The primary emission sources of criteria pollutants are the steam plants at K–25, Y–12, and ORNL. Other emission sources include fugitive particulates from coal piles, the TSCA incinerator, other processes, vehicles, and temporary emissions from various construction activities (OR DOE 1987a:33-49). Appendix F presents emissions of criteria pollutants from ORR.

Table 3.6.3–1 presents the baseline ambient air concentration for criteria pollutants and other pollutants of concern at ORR. As shown in the table, baseline concentrations are in compliance with applicable guidelines and regulations.

Noise. Major noise emission sources within ORR include various industrial facilities, equipment, and machines (for example, cooling systems, transformers, engines, pumps, boilers, steam vents, paging systems, construction and materials-handling equipment, and vehicles). Most ORR industrial facilities are at a sufficient distance from the site boundary that noise levels at the boundary from these sources would not be measurable or would be barely distinguishable from background noise levels.

Sound-level measurements have been recorded at various locations within and near ORR in the process of testing sirens and preparing support documentation for the Atomic Vapor Laser Isotope Separation site (ORR 1991a:2; ORR 1991a:6). The acoustic environment along the ORR site boundary in rural areas and at nearby residences away from traffic noise is typical of a rural location, with the average DNL in the range of 35 to 50 dBA. Areas near the site within Oak Ridge are typical of a suburban area, with the average DNL in the range of 53 to 62 dBA (EPA 1974a:B-4,B-5). The primary source of noise at the site boundary and at residences located near roads is traffic. During peak hours, the plant traffic is a major contributor to traffic noise levels in the area.

The State of Tennessee has not established specific community noise standards applicable to ORR. The city of Oak Ridge has specific acceptable sound levels at property lines (Appendix F).

Table 3.6.3–1. Comparison of Baseline Ambient Air Concentrations With Most Stringent Applicable Regulations or Guidelines at Oak Ridge Reservation, 1992

Pollutant	Averaging Time	Most Stringent Regulation or Guideline[a] ($\mu g/m^3$)	Baseline Concentration ($\mu g/m^3$)
Criteria Pollutants			
Carbon monoxide	8-hour	10,000[b]	5
	1-hour	40,000[b]	11
Lead	Calendar Quarter	1.5[b]	0.05[c]
Nitrogen dioxide	Annual	100[b]	3
Ozone	1-hour	235[b]	[d]
Particulate matter less than or equal to 10 microns in diameter	Annual	50[b]	1
	24-hour	150[b]	2
Sulfur dioxide	Annual	80[b]	2
	24-hour	365[b]	32
	3-hour	1,300[b]	80
Mandated by the State of Tennessee			
Total suspended particulates	24-hour	150[e]	2[f]
Gaseous fluoride (as hydrogen fluoride)	30-day	1.2[e]	0.2
	7-day	1.6[e]	0.3
	24-hour	2.9[e]	0.6[g]
	12-hour	3.7[e]	0.6[g]
	8-hour	250[e]	0.6
Hazardous and Other Toxic Compounds			
1,1,1-Trichloroethane	8-hour	[h]	[d]
Acetic Acid	8-hour	[h]	<0.01
Chlorine	8-hour	150[e]	4.1
Hydrogen chloride	8-hour	750[e]	57.0
Mercury	8-hour	5[e]	0.06[i]
Nitric acid	8-hour	[h]	78.0
Sulfuric acid	8-hour	100[e]	20.0

[a] The more stringent of the Federal and State standard is presented if both exist for the averaging time.
[b] Federal and State standard.
[c] Value is maximum for 24-hour period.
[d] Data not available from source document.
[e] State standard.
[f] Based on stack emissions of particulate matter only.
[g] 8-hour concentration was used.
[h] No State standard for indicated averaging time.
[i] Annual average (monitored value).

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the site. See Section 4.1.3 for a discussion of ozone-related issues.

Source: 40 CFR 50; OR DOE 1993a; TN DEC 1994a; TN DHE 1991a.

3.6.4 WATER RESOURCES

Surface Water. The major surface water body in the immediate vicinity of ORR is the Clinch River, which borders the site to the south and west. There are four major sub-drainage basins on ORR that flow into the Clinch River and are affected by site operations: Poplar Creek, East Fork Poplar Creek, Bear Creek, and White Oak Creek. Several smaller drainage basins, including Ish Creek, Grassy Creek, Bearden Creek, McCoy Branch, Kerr Hollow Branch, and Raccoon Creek drain directly to the Clinch River. Each drainage basin takes the name of the major stream flowing through the area. Within each basin are a number of small tributaries. The natural surface water bodies in the vicinity of ORR are shown on Figure 3.6.4–1.

The three major facilities at ORR each affect different basins of the Clinch River. Drainage from Y–12 enters both Bear Creek and East Fork Poplar Creek; K–25 drains predominantly into Poplar Creek; and ORNL drains into the White Oak Creek drainage basin.

The Clinch River and connected waterways supply all raw water for ORR. The Clinch River has an average flow rate of 132 m^3/s (4,647 ft^3/s) as measured at the downstream side of Melton Hill Dam at mile 23.1 (OR USGS 1986a:161). The average flow rate of Grassy, Ish, and Bear Creeks in the ORR area are 0.08 m^3/s (2.8 ft^3/s), 0.05 m^3/s (1.8 ft^3/s), and 0.11 m^3/s (3.9 ft^3/s), respectively. The average flow rate at East Fork Poplar Creek is 1.46 m^3/s (51.4 ft^3/s). Y–12 uses approximately 7,530 million l/yr (2 billion gal/yr) of water, and ORR uses 14,210 million l/yr (3,754 million gal/yr). The ORR water supply system, which includes the DOE treatment facility and the K–25 treatment facility, has a capacity of 121.5 million l/day (32.1 million gal/day).

The Clinch River water levels in the vicinity of ORR are regulated by a system of dams operated by the TVA. Melton Hill Dam controls the flow of the Clinch River along the northeast and southeast sides of ORR. Watts Bar Dam, on the Tennessee River near the lower end of the Clinch River, controls the flow of the Clinch River along the southwest side of ORR.

The TVA has conducted flood studies along the Clinch River, Bear Creek, and East Fork Poplar Creek (OR TVA 1991a:1). Portions of Y–12 lie within the 100- and 500-year floodplains of East Fork Poplar Creek (ORNL 1995d). Studies have not been performed to delineate the 100- or 500-year floodplain boundaries of Grassy, Ish, and Bear Creeks in the western half of the facility (OR TVA 1991a:1). A site-specific assessment would be required before constructing any new facility at ORR.

Surface Water Quality. The streams and creeks of Tennessee are classified by the Tennessee Department of Environmental Conservation (TDEC) and defined in the State of Tennessee Water Quality Standards. Classifications are based on water quality, designated uses, and resident aquatic biota. The Clinch River is the only surface water body on ORR classified for domestic water supply. Streams at ORR are classified for fish, aquatic life, and livestock watering; irrigation; recreation; and wildlife. White Oak Creek and Melton Branch are the only streams not classified for irrigation. Portions of Poplar Creek, East Fork Poplar Creek, and Melton Branch are not classified for recreation.

Both routine and NPDES-required surface water monitoring programs (over 225 sites) are performed at Y–12 to assess the impacts of the plant effluents upon natural receiving water and to estimate the impacts of these effluents on human health and the environment. At Y–12, Bear Creek, McCoy Branch, Rogers Quarry, and East Fork Poplar Creek receive effluent from treated sanitary wastewater, industrial discharges, cooling water blowdown, stormwater, surface water runoff, and groundwater. The chemical water quality of Bear Creek has been affected by the infiltration of contaminated groundwater. Contaminants included high concentrations of dissolved salts, several metals, chlorinated solvents, and PCBs. DOE is currently involved with remediation of East Fork Poplar Creek under CERCLA, because the creek was contaminated by past releases from Y–12. Significant cleanup activities are required onsite and offsite. Contaminants present in East Fork Poplar Creek included mercury, organics, PCBs, and radionuclides (OR DOE 1994d:5-9).

Wastewater treatment facilities are located throughout ORR. At Y–12, there are six treatment facilities with NPDES-permitted discharge points to East Fork Poplar Creek. Y–12 also has a permit to discharge wastewater to the Oak Ridge Treatment Facility. At ORNL, there are three NPDES-permitted wastewater treatment facilities discharging into White Oak Creek basin. K–25 operates one sanitary sewage system discharging to Poplar Creek.

There are 455 NPDES-permitted outfalls associated with the three major facilities at ORR; many of these are stormwater outfalls. Approximately 57,000 NPDES laboratory analyses were completed in 1993, with a compliance rate of over 99 percent. Most excursions were associated with precipitation runoff (OR DOE 1994c:2-13). One Notice of Violation was issued by TDEC in 1993 for exceeding permit limits for total suspended solids at three outfalls at ORNL. An action plan was prepared addressing projects to mitigate the potential for future violations.

As shown in Table 3.6.4–1, maximum concentrations of all parameters except nitrate and manganese were within the various comparison water quality criteria where the Clinch River leaves ORR. Monitoring data from this sampling site were compared with data from the Melton Hill Dam sampling site, located upstream of all ORR discharges and therefore are representative of background water quality. The concentrations downstream of ORR discharges were lower than concentrations upstream in all cases except gross beta and total suspended solids. Concentrations at Melton Hill Dam were within applicable water quality criteria.

Surface Water Rights and Permits. In Tennessee, the State's water rights laws are established in the *Water Quality Control Act*. In effect, the water rights are similar to riparian rights, in that the designated usages of a water body cannot be impaired. The only requirement to withdraw water from available supplies would be a U.S. Army COE permit to construct intake structures.

Groundwater. The ORR is located in an area of sedimentary rocks of widely varying hydrological character. However, because of the topographic relief and a decrease in bedrock fracture density with depth, groundwater flow is restricted primarily to shallow depths and groundwater discharges primarily to nearby surface waters within ORR. Depth to groundwater is generally 5 to 9 m (16 to 30 ft), but is as little as 1.5 m (5 ft) in the area of Bear Creek Valley near State Route 95. No Class I sole source aquifers lie beneath ORR. All aquifers are considered Class II (current and potential sources of drinking water).

Aquifers at ORR include a surficial soil and regolith unit and bedrock aquifers. The surficial aquifer consists of manmade fill, alluvium, and weathered bedrock. Bedrock aquifers occur in carbonates and low-yield sandstones, siltstones, and shales. Groundwater flow in the surficial aquifer is controlled by bedding planes, joints, fracture and/or solution cavity distribution and orientation in limestones that store and transmit relatively large volumes of water. Bedding-plane and strike-parallel fracture orientation give rise to preferential groundwater movement along strike direction (OR DOE 1992c:5-7). In the bedrock aquifer, essentially all groundwater occurs in fractures and in a few larger cavities within the formation. Enlarged fractures and cavities are the primary water producing and solute transport features and are supplied by seepage through fractures in the rock matrix, which outnumber the enlarged fractures and cavities, are interconnected, and provide the continuity for groundwater flow paths. Movement of groundwater through fractures and solution conduits in some of the carbonate aquifers is quite rapid even where gradients are not particularly steep.

Recharge occurs over most of the area but is most effective where overburdened soils are thin or permeable. In the area near Bear Creek Valley, recharge into the carbonate rocks is mainly along Chestnut Ridge (OR DOE 1992c:5-5). Groundwater generally flows from the recharge areas to the center of Bear Creek Valley and discharges into Bear Creek and its tributaries. Because of the abundance of surface water and its proximity to the points of use, very little groundwater is used at ORR. Only one water supply well exists on ORR; it provides a supplemental water supply to an aquatics laboratory during extended droughts.

Table 3.6.4–1. Summary of Clinch River Surface Water Quality Monitoring at Oak Ridge Reservation, 1993

Parameter	Unit of Measure	Water Quality Criteria and Standards[a]	Water Body Concentration	
			High	Low
Alpha (gross)	pCi/l	15[b]	1.6	-0.14
Beta (gross)	pCi/l	50[c]	6.8	3.8
Cesium-137	pCi/l	120[d]	4.1	-2.4
Chemical oxygen demand	mg/l	NA	21	<5.0
Fluoride	mg/l	4.0[b], 2.0[e]	0.10	<0.10
Manganese	mg/l	0.05[e]	0.068	0.0031
Nitrate	mg/l	10.0[b]	10.0	1.5
pH	pH units	6.5-8.5[f]	8.2	7.8
Sodium	mg/l	NA	4.9	3.3
Sulfate	mg/l	250[e]	27	15
Suspended solids	mg/l	NA	29	<5.0
Technetium-99	pCi/l	4,000[d]	5.9	-0.54
Total dissolved solids	mg/l	500[e]	170	150
Tritium	pCi/l	80,000[d]	540	-570
Uranium, Total	mg/l	0.02[c]	0.0010	<0.00010

[a] For comparison purposes only.
[b] National Primary Drinking Water Regulations (40 CFR 141).
[c] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).
[d] DOE DCG for water (DOE Order 5400.5). DCG values are based on a committed effective dose equivalent of 100 mrem per year; however, because the drinking water maximum contaminant level is based on 4 mrem per year, the number listed is 4 percent of the DCG. All concentrations of radionuclides are determined by subtracting the instrument background environmental level from the monitored location. A negative or zero incremental concentration means that the concentration at the sampling location is equivalent to the background environmental level.
[e] National Secondary Drinking Water Regulations (40 CFR 143).
[f] Tennessee drinking water quality standards.

Note: Data from 1993 sampling event at Station CRK16, located on the Clinch River, downstream from ORR. NA=not applicable.
Source: OR DOE 1994f; TN DEC 1991a.

Groundwater Quality. Groundwater samples are collected quarterly from more than 1,000 monitoring wells throughout ORR. Groundwater samples collected from the monitoring wells are analyzed for a standard suite of parameters and constituents, including trace metals, volatile organic compounds, radioactive materials, and pH. Background groundwater quality at ORR is generally good in the near-surface aquifer zones and poor in the bedrock aquifer at depths greater than 305 m (1,000 ft) due to high total dissolved solids.

Groundwater in Bear Creek Valley near Y–12 and in the ORNL and K–25 areas has been contaminated by hazardous chemicals and radionuclides (mostly uranium) from weapons production process activities. The contaminated sites include past waste disposal sites, waste storage tanks, spill sites, and contaminated inactive facilities. The groundwater quality as indicated by groundwater contamination monitoring wells at ORR is summarized in Table 3.6.4–2.

Groundwater Availability, Use, and Rights. Industrial and drinking water supplies in the area are primarily taken from surface water sources. However, single-family wells are common in adjacent rural areas not served by the public water supply system (OR DOE 1992c:1-15). Most of the residential supply wells in the immediate area of ORR are south of the Clinch River. Most wells used for potable water are in the deeper principal carbonate

Table 3.6.4–2. Groundwater Quality Monitoring at Oak Ridge Reservation, 1993

Parameter	Unit of Measure	Water Quality Criteria and Standard[a]	Existing Conditions[b] High	Existing Conditions[b] Low
Alkalinity-CO_3	mg/l	NA	190	1
Alkalinity-HCO_3	mg/l	NA	540	2
Alpha (gross)	pCi/l	15[c]	490	-52
Aluminum	mg/l	0.05-0.2[d]	140	<0.019
Barium	mg/l	2.0[c]	33	0.0016
Beta (gross)	pCi/l	50[e]	11,000	-23
Boron	mg/l	NA	1.6	0.0041
Calcium	mg/l	NA	6,600	0.85
Chloride	mg/l	250[d]	3,900	0.1
Chromium	mg/l	0.1[c,f]	58	<0.0033
Copper	mg/l	1.0[d]	1.1	<0.0033
Fluoride	mg/l	2.0[d], 4.0[c]	6.0	<0.1
Iron	mg/l	0.3[d]	470	0.0050
Lead	mg/l	0.005[f]	1.7	<0.0012
Magnesium	mg/l	NA	430	0.019
Manganese	mg/l	0.05[d]	29	0.001
Nickel	mg/l	0.1[c]	5.8	<0.0042
Nitrate	mg/l	10.0[c]	5,500	0.2
pH	pH units	6.5-8.5[d]	12	4.5
Potassium	mg/l	NA	32	0.60
Sodium	mg/l	NA	2,100	0.23
Strontium-90	pCi/l	400[g]	7,600	-16
Sulfate	mg/l	250[d]	2,100	1.0
Total dissolved solids	mg/l	500[d]	26,000	32
Uranium-235	pCi/l	24[g]	200	-70
Uranium-238	pCi/l	24[g]	120	-18
Vanadium	mg/l	NA	1.1	<0.002
Zinc	mg/l	5.0[d]	3.8	0.0020

[a] For comparison purposes only.
[b] Data are from all wells on ORR.
[c] National Primary Drinking Water Regulations (40 CFR 141).
[d] National Secondary Drinking Water Regulations (40 CFR 143).
[e] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).
[f] Tennessee drinking water standards.
[g] DOE DCG for water (DOE Order 5400.5). DCG values are based on a committed effective dose equivalent of 100 mrem per year; however, because the drinking water maximum contaminant level is based on 4 mrem per year, the number listed is 4 percent of the DCG. All concentrations of radionuclides are determined by subtracting the instrument background environmental level from the monitored location. A negative or zero incremental concentration means that the concentration at the sampling location is equivalent to the background environmental level.

Note: NA=not applicable.

Source: OR DOE 1994f; TN DEC 1991a.

aquifers (up to 305 m [1,000 ft]), while the groundwater contamination at Y–12 is primarily found at depths up to 84 m (276 ft).

Groundwater rights in the State of Tennessee are traditionally associated with the Reasonable Use Doctrine (VDL 1990a:725). Under this doctrine, landowners can withdraw groundwater to the extent that they must exercise their rights reasonably in relation to the similar rights of others.

3.6.5 GEOLOGY AND SOILS

Geology. The ORR is located in the Valley and Ridge physiographic province of east-central Tennessee. The topography consists of alternating valleys and ridges that have a northeast-southwest trend, with most ORR facilities occupying the valleys; Y–12 is located in Bear Creek Valley between Pine and Chestnut Ridges. ORNL and K–25 are underlain primarily by calcareous siltstones and silty to clean limestones of the Chickamauga Group; Y–12 is underlain by the Conasauga Group, which is composed of shales, calcareous siltstones, and silty to clean limestones. Pine Ridge is underlain by the Rome Formations, which consist of sandstone with thin shale interbeds. Chestnut Ridge is underlain by the cherty dolostones of the Knox Group. The present topography of the valleys is a result of stream action preferentially eroding the softer shales and limestones; the ridges are composed of relatively more resistant sandstones and dolomites. No economically viable geologic resources have been identified at ORR.

Oak Ridge Reservation is underlain by many inactive faults formed during the Late Paleozoic Era. There is no evidence of capable faults, as defined in 10 CFR 100, Appendix A, in the immediate area of ORR. The nearest capable faults are located approximately 480 km (298 mi) northwest in the New Madrid fault zone (OR EG&G 1991a:3.6.2–6).

The Oak Ridge Reservation area is located at the boundary between Seismic Zones 1 and 2, indicating that minor to moderate damage could occur as a result of earthquakes (Figure 3.2.5–1). Since the New Madrid earthquakes of 1811–12, at least 27 other earthquakes with an MMI of III to VI have been felt in the Oak Ridge area (Table 3.2.5–1). The nearest seismic event occurred in 1930 approximately 8 km (5 mi) from ORR and had an MMI of V at the site (OR EG&G 1991a:3.6.2-1). The most recent significant earthquake (4.6 on the Richter scale) occurred on November 30, 1973 in Maryville, Tennessee, approximately 34 km (21 mi) southeast of ORR.

There is no volcanic hazard at ORR. The area has not experienced volcanic activity within the last 230 million years. Therefore, future volcanic activity is not anticipated.

Soils. Bear Creek Valley lies on well-drained to moderately well-drained soils underlain by shale, siltstone, and sandstone. Developed portions of the valley are designated as urban land. Soil erosion from past land uses has ranged from slight to severe. Erosion potential is very high in those areas with slopes greater than 25 percent and which have been eroded in the past. Erosion potential is lowest in nearly flat-lying permeable soils that have a loamy texture (ORNL 1988b:69). Additionally, wind erosion is slight, shrink-swell potential is low to moderate, and the soils are acceptable for standard construction techniques.

3.6.6 BIOLOGICAL RESOURCES

Terrestrial Resources. Plant communities at ORR are characteristic of the intermountain regions of central and southern Appalachia. Approximately 10 percent of ORR has been disturbed since it was withdrawn from public access; the remainder of the site has reverted to, or been planted with, natural vegetation (OR DOE 1989a:3-5). The vegetation of ORR has been categorized into seven plant communities (Figure 3.6.6–1).

Pine and pine-hardwood forest is the most extensive plant community on ORR. Important species of this community type include loblolly pine, shortleaf pine, and Virginia pine (ORNL 1987a:9). Another abundant plant community is the oak-hickory forest, which is commonly found on ridges throughout ORR. Northern hardwood forest and hemlock-white pine-hardwood forest are the least common forest community types on ORR. Forest resources on ORR are managed for maintaining multiple use of forest land and sustaining yield of quality timber products (OR DOE 1994e:2-113). Nine hundred eighty-three species, subspecies, and varieties of plants have been identified on ORR (OR NERP 1993b:2).

Animal species found on ORR include 26 amphibian, 33 reptile, 169 bird, and 39 mammal species (OR NERP nda:8-17). Animals commonly found on ORR include the American toad, eastern garter snake, Carolina chickadee, northern cardinal, white-footed mouse, and raccoon. Although the whitetail deer is the only species hunted onsite (OR DOE 1991c:4-6), other game animals are also present. Raptors, such as the northern harrier and great horned owl, and carnivores, such as the gray fox and mink, are ecologically important groups on ORR. A variety of migratory birds has been found at ORR. Migratory birds, as well as their nests and eggs, are protected by the *Migratory Bird Treaty Act*.

Vegetative communities in the area proposed for the consolidated Pu storage facility (which is also the assumed analysis site for immobilization facilities) are typical of ORR as a whole, with pine and pine-hardwood and oak-hickory forests being the predominant community types (Figure 3.6.6–1). Fauna of the proposed storage site would be similar to that found throughout ORR. The assumed site for the evolutionary LWR was originally dominated by pine and pine-hardwood forests. However, it was cleared for a previously proposed breeder reactor and thus, is presently in a highly disturbed state.

Wetlands. Wetlands on ORR include emergent, scrub and shrub, and forested wetlands associated with embayments of the Melton Hill and Watts Bar Lake, riparian areas bordering major streams and their tributaries, old farm ponds, and groundwater seeps. Well-developed communities of emergent wetland plants in the shallow embayments of the two reservoirs typically intergrade into forested wetland plant communities, which extend upstream through riparian areas associated with streams and their tributaries. Old farm ponds on ORR vary in size and support diverse plant communities and fauna. Although most riparian wetlands on ORR are forested, areas within utility rights-of-way, such as those in Bear Creek and Melton Valleys, support emergent wetland vegetation (OR NERP 1991a:4,18,26,41).

Within the vicinity of the site proposed for the consolidated Pu storage facility (which is also the assumed analysis site for immobilization facilities), most wetlands are forested and are located in riparian areas bordering headwater tributaries to Bear Creek, Grassy Creek, and Ish Creek (Figure 3.6.4-1). Forested wetlands also occupy several acres in the floodplain of Bear Creek as it flows through the area. Emergent wetlands are present where tributaries to Grassy Creek cross a power line paralleling Bear Creek Road.

Portions of the forested wetland in the Bear Creek floodplain located near the northern edge of the proposed consolidated Pu storage site are designated as an NERP Reference Area and Natural Area. This wetland area is uncommon because it is not subject to the changing water levels from the TVA dams, and it has a deep, organic substrate combined with a diversity of herbaceous plants. The springs, seeps, and old streambeds create a variety of habitats. This wetland supports a State-listed endangered plant species (tubercled rein-orchid). A portion of the Reference Area and the entire Natural Area have been designated as State Natural Areas (OR NERP

1993a:13). The assumed location for the evolutionary LWR is highly disturbed and does not contain any wetlands.

Aquatic Resources. Aquatic habitat on or adjacent to ORR ranges from small, free-flowing streams in undisturbed watersheds to larger streams with altered flow patterns due to dam construction. These aquatic habitats include tailwaters, impoundments, reservoir embayments, and large and small perennial streams. Aquatic areas in ORR also include seasonal and intermittent streams.

Sixty-four fish species have been collected on or adjacent to ORR. The minnow family has the largest number of species and is numerically dominant in most streams (ORNL 1988c:0-43). Fish species representative of the Clinch River in the vicinity of ORR are shad, herring, common carp, catfish, bluegill, crappie, and freshwater drum (ORNL 1981b:138-149). The most important fish species taken commercially in the ORR area are common carp and catfish. Commercial fishing is permitted on the Clinch River downstream from Melton Hill Dam (TN WRA 1995a:1-5). Area recreational species consist of crappie, largemouth bass, sauger, sunfish, and catfish (TN DEC 1992e:1; TN WRA 1993a:1). Sport fishing is not permitted within ORR (TN WRA 1992a:1).

Fish species that have been recorded near the site of the proposed consolidated Pu storage facility (which is also the assumed analysis site for immobilization facilities) include 18 species in Bear Creek, 15 species in Grassy Creek, and 8 species in Ish Creek. Fish found in these streams include: blacknose dace, creek chub, shiner, Tennessee dace, banded sculpin, central stoneroller, bluntnose minnow, redbreast sunfish, and rock bass (OR DOE 1984a:3-30; ORNL 1988c:4-10; ORNL 1992c:4-5–4-7).

A NERP Aquatic Reference Area is located along Grassy Creek and its tributaries in the western portion of the proposed consolidated Pu storage site (OR NERP 1993a:16). Grassy Creek has a diverse assemblage of invertebrates and fish species for a stream its size. ORR uses Grassy Creek as a reference area for studies of other streams affected by site development. The assumed site for the evolutionary LWR is highly disturbed and does not contain any aquatic resources.

Threatened and Endangered Species. Eighty-four federally and State-listed threatened, endangered, and other special status species may be found on and in the vicinity of ORR (Table 3.6.6–1). Twenty-six of these species have records of occurrence on ORR or adjacent lakes. Seventeen of these are federally and/or State-listed as threatened or endangered, most of which are plant species located within NERP National Areas on ORR. Once a specific project site location has been determined, site surveys will verify the presence of special status species. No critical habitat for threatened or endangered species, as defined in the ESA (50 CFR 17.11; 50 CFR 17.12), exists on ORR or adjacent lakes.

The bald eagle is the only federally listed threatened or endangered species observed near ORR on Melton Hill and Watts Bar Lakes. The peregrine falcon may occur in the area as a rare migrant or winter visitor. [Text deleted.] State-listed threatened or endangered species observed on ORR include the osprey and fourteen plant species (Table 3.6.6–1).

No federally listed threatened and endangered species are known to occur in the proposed storage site (which is also the assumed analysis site for immobilization facilities). [Text deleted.] East Fork Poplar Creek, north of the proposed storage site, contains suitable habitat for the Indiana bat. ORR lies within the geographic range of the gray bat, but suitable caves for this species are not known to occur on or near the proposed storage site. Neither of these bat species was collected during a limited survey conducted in 1992 (OR TT 1993a:1). [Text deleted.]

A number of State-listed threatened and endangered species are known to occur in the vicinity of the proposed consolidated Pu storage facility site (ORNL 1987b:11,12). These include Cooper's hawk, sharp-shinned hawk, pink lady's-slippers, tubercled rein-orchid, purple fringeless orchid, American ginseng, and fen orchid (OR NERP 1993a:6). One species listed by the State as in need of management (the Tennessee dace) occurs on the proposed site. The Tennessee dace is an inhabitant of Bear Creek and its tributaries. This stream system, which

Table 3.6.6–1. Federally and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found on or in the Vicinity of Oak Ridge Reservation

Common Name	Scientific Name	Status[a] Federal	Status[a] State
Mammals			
Alleghany woodrat	*Neotoma magister*	NL	D
Eastern cougar[b]	*Felis concolor couguar*	E	E
Eastern small-footed bat	*Myotis leibii*	NL	D
Gray bat[b]	*Myotis grisescens*	E	E
Indiana bat[b]	*Myotis sodalis*	E	E
Rafinesque's big-eared bat	*Plecotus rafinesquii*	NL	D
River otter	*Lutra canadensis*	NL	T
Smoky shrew	*Sorex fumeus*	NL	D
Southeastern shrew	*Sorex longirostris*	NL	D
Birds			
American peregrine falcon[b]	*Falco peregrinus anatum*	E	E
Appalachian Bewick's wren	*Thryomanes bewickii altus*	NL	T
Arctic peregrine falcon	*Falco peregrinus tundrius*	E(S/A)	E
Bachman's sparrow	*Aimophila aestivalis*	NL	E
Bald eagle[b,c]	*Haliaeetus leucocephalus*	T	T
Barn owl[d]	*Tyto alba*	NL	D
Cooper's hawk[d,e]	*Accipiter cooperii*	NL	D
Grasshopper sparrow	*Ammodramus savannarum*	NL	D
Northern harrier	*Circus cyaneus*	NL	D
Osprey[d]	*Pandion haliaetus*	NL	T
Red-cockaded woodpecker	*Picoides borealis*	E	E
Sharp-shinned hawk[d,e]	*Accipiter striatus*	NL	D
Swainson's warbler	*Limnothlypis swainsonii*	NL	D
Reptiles			
Eastern slender glass lizard	*Ophisaurus attenuatus longicaudus*	NL	D
Northern pine snake	*Pituophis melanoleucus melanoleucus*	NL	T
Amphibians			
[Text deleted.]			
Hellbender[d,e]	*Cryptobranchus alleganiensis*	NL	D
Tennessee cave salamander[f]	*Gyrinophilus palleucus*	NL	T
Fish			
Alabama shad	*Alosa alabamae*	NL	D
Amber darter[b]	*Percina antesella*	E	E
Blue sucker	*Cycleptus elongatus*	NL	T
Flame chub	*Hemitremia flammea*	NL	D
Frecklebelly madtom	*Noturus munitus*	NL	T
Highfin carpsucker	*Carpiodes velifer*	NL	D
Spotfin chub[b]	*Cyprinella monacha*	T	E
Tennessee dace[d,e]	*Phoxinus tennesseensis*	NL	D
Yellowfin madtom[b]	*Noturus flavipinnis*	T	E

Table 3.6.6–1. Federally and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found on or in the Vicinity of Oak Ridge Reservation—Continued

Common Name	Scientific Name	Status[a] Federal	State
Invertebrates			
Alabama lampmussel[b]	*Lampsilis virescens*	E	E
Appalachian monkeyface pearlymussel[b]	*Quadrula sparsa*	E	E
Birdwing pearlymussel[b]	*Conradilla caelata*	E	E
Cumberland bean pearlymussel[b]	*Villosa trabalis*	E	E
Cumberland monkeyface pearlymussel[b]	*Quadrula intermedia*	E	E
Dromedary pearlymussel[b]	*Dromus dromas*	E	E
Fine-rayed pigtoe[b]	*Fusconaia cuneolus*	E	E
Green-blossom pearlymussel[b]	*Epioblasma torulosa gubernaculum*	E	E
Orange-footed pearlymussel[b]	*Plethobasus cooperianus*	E	E
Painted snake coiled forest snail	*Anguispira picta*	T	E
Pale lilliput pearlymussel[b]	*Toxolasma cylindrellus*	E	E
Pink mucket pearlymussel[b]	*Lampsilis abrupta*	E	E
Rough pigtoe[b]	*Pleurobema plenum*	E	E
Shiny pigtoe[b]	*Fusconaia cor*	E	E
Tan riffleshell[b]	*Epioblasma walkeri*	E	E
Tubercled-blossom pearlymussel[b]	*Epioblasma torulosa torulosa*	E	E
Turgid-blossom pearlymussel[b]	*Epioblasma turgidula*	E	E
White wartyback pearlymussel[b]	*Plethobasus cicatricosus*	E	E
Yellow-blossom pearlymussel[b]	*Epioblasma florentina florentina*	E	E
Plants			
American barberry	*Berberis canadensis*	NL	S
American ginseng[d,e]	*Panax quinquefolius*	NL	T
Appalachian bugbane[d]	*Cimicifuga rubifolia*	NL	T
Auriculate false-foxglove	*Tomanthera auriculata*	NL	E
Branching whitlowgrass	*Draba ramosissima*	NL	S
Butternut[d]	*Juglans cinerea*	NL	T
Canada (wild yellow) lily[d,e]	*Lilium canadense*	NL	T
Carey's saxifrage[d]	*Saxifraga careyana*	NL	S
Fen orchid[d,e]	*Liparis loeselii*	NL	E
Golden seal[d,e]	*Hydrastis canadensis*	NL	T
Gravid sedge[d,e]	*Carex gravida*	NL	S
Heartleaf meehania	*Meehania cordata*	NL	T
Heller's catfoot	*Gnaphalium helleri*	NL	S
Lesser ladies' tresses[d]	*Spiranthes ovalis*	NL	S
Michigan lily[d,e]	*Lilium michiganense*	NL	T
Mountain honeysuckle	*Lonicera dioica*	NL	S
Mountain witch alder[d]	*Fothergilla major*	NL	T
Northern bush honeysuckle[d]	*Diervilla lonicera*	NL	T
Nuttall waterweed[d]	*Elodea nuttallii*	NL	S
Pink lady's-slipper[d,e]	*Cypripedium acaule*	NL	E
Prairie goldenrod	*Solidago ptarmicoides*	NL	E
Purple fringeless orchid[d,e]	*Platanthera peramoena*	NL	T

Table 3.6.6–1. Federally and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found on or in the Vicinity of Oak Ridge Reservation—Continued

Common Name	Scientific Name	Status[a] Federal	Status[a] State
Plants (continued)			
Slender blazing star	*Liatris cylindracea*	NL	E
Spreading false foxglove[d]	*Aureolaria patula*	NL	T
Swamp lousewort	*Pedicularis lanceolata*	NL	T
Tall larkspur[d]	*Delphinium exaltatum*	NL	E
Tennessee purple coneflower[b]	*Echinacea tennesseenis*	E	E
Tubercled rein-orchid[d,e]	*Platanthera flava var. herbiola*	NL	T
Virginia spiraea	*Spiraea virginiana*	T	E
Whorled mountainmint	*Pycnanthemum verticillatum*	NL	E-P

[a] Status codes: D=deemed in need of management; E=endangered; NL=not listed; P=possibly extirpated; S=species of special concern; S/A=protected under the similarity of appearances provision of the ESA; T=threatened.

[b] USFWS Recovery Plan exists for this species.

[c] Observed near ORR on Melton Hill and Watts Bar Lakes.

[d] Recent record of species occurrence on ORR.

[e] Species known to occur on or near proposed site for the New Pu Consolidated Storage Facility.

[f] Species collected on ORR in 1964.

Source: 50 CFR 17.11; 50 CFR 17.12; DOE 1995w; OR DOE 1990a; OR FWS 1992b; OR NERP 1993a; ORNL 1981a; ORNL 1984b; ORNL 1988c; TN DEC 1995a; TN DEC 1995b; TN DEC 1995c; TN DEC 1995d; TN WRC 1991a; TN WRC 1991b.

flows through the proposed site, is designated as a NERP Aquatic Natural Area. The habitat of this fish is protected by the State. Bear Creek is the site of life history studies of the Tennessee dace and may contain the greatest density of this species in the State (OR NERP 1993a:10,11). [Text deleted.]

The assumed location for the evolutionary LWR has been highly disturbed by land-clearing activities associated with the breeder reactor. It is unlikely that any species of special concern would reside on this site, although some listed birds and bats could use it to forage for food.

3.6.7 CULTURAL AND PALEONTOLOGICAL RESOURCES

Prehistoric Resources. More than 20 cultural resources surveys have been conducted at ORR. About 90 percent of ORR has received at least some preliminary walkover or archival-level study, but less than 5 percent has been intensively surveyed. Most cultural resources studies have occurred along the Clinch River and adjacent tributaries. Prehistoric sites recorded at ORR include villages, burial mounds, camps, quarries, chipping stations, limited activity locations, and shell scatters. Over 45 prehistoric sites have been recorded at ORR to date. At least 13 prehistoric sites are considered potentially eligible for the NRHP, but most of these sites have not yet been evaluated. Site 40RE86 has been determined eligible for inclusion on the NRHP. Additional prehistoric sites may be identified in the unsurveyed portions of ORR. On May 6, 1994, a Programmatic Agreement concerning the management of historic and cultural properties at ORR was executed among the DOE Oak Ridge Operations Office, the Tennessee SHPO, and the Advisory Council on Historic Preservation. This agreement was administered to satisfy DOE's responsibilities regarding Sections 106 and 110 of the *National Historic Preservation Act* (NHPA), and requires DOE to develop a cultural resources management plan for ORR and to conduct cultural resources surveys as required.

Historic Resources. Several historic resources surveys have been conducted at ORR. Historic resources identified at ORR include both archaeological remains and standing structures. Documented log, wood frame, or fieldstone structures include cabins, barns, churches, gravehouses, springhouses, storage sheds, smokehouses, log cribs, privies, henhouses, and garages. Archaeological remains consist primarily of foundations, roads, and trash scatters. Sixty-nine pre-1942 cemeteries were located within the original ORR (OR Robinson 1950a:130). Today there are 32 known cemeteries within ORR because the size of the reservation has been reduced. More than 240 historic resources have been recorded at ORR, and 38 of those sites may be considered potentially NRHP-eligible. Freel's cabin and two church structures, George Jones Memorial Baptist Church and the New Bethel Baptist Church, are listed on the NRHP. These structures date from before the establishment of the Manhattan Project. NRHP sites associated with the Manhattan Project include the Graphite Reactor at ORNL, listed on the NRHP as a National Historic Landmark, and three traffic checkpoints, Bear Creek Road, Bethel Valley Road, and Oak Ridge Turnpike Checking Stations. Many other buildings and facilities at ORR are associated with the Manhattan Project and may be potentially eligible for the NRHP. Historic building surveys were completed during Fiscal Year 1994 at K–25 and ORNL. A similar survey was completed at Y–12, and the final document should be finished in Fiscal Year 1996. Based on this survey, approximately 100 additional buildings may be eligible for listing on the NRHP. Additional historic sites may be anticipated in the unsurveyed portions of ORR.

Native American Resources. The Overhill Cherokee occupied portions of the Tennessee, Hiwassee, Clinch, and Little Tennessee River Valley in the 1700s. Overhill Cherokee villages consisted of a large townhouse, a summer pavilion, and a plaza; residences had both summer and winter structures. Subsistence was based on hunting, gathering, and horticulture. The Cherokee were relocated to the Oklahoma territory in 1838; some Cherokee later returned to the area from Oklahoma. DOE has consulted with the Eastern Band of the Cherokee concerning activities at ORR. Resources that may be sensitive to Native American groups include remains of prehistoric and historic villages, ceremonial lodges, cemeteries, burials, and traditional plant gathering areas. Apart from prehistoric archaeological sites, no Native American resources have been identified to date at ORR.

Paleontological Resources. The majority of geological units with surface exposures at ORR contain paleontological materials. Paleontological materials consist primarily of invertebrate remains, and these assemblages have relatively low research potential.

3.6.8 SOCIOECONOMICS

Socioeconomic characteristics described for ORR include employment and regional economy, population and housing, community services, and local transportation. Statistics for employment and regional economy are presented for the REA that encompasses 15 counties around ORR located in Tennessee (Table L.1–1). Statistics for population and housing, community services, and local transportation are presented for the ROI, a four-county area in which 90.8 percent of all ORR employees reside: Anderson County (29.5 percent), Knox County (41.3 percent), Loudon County (5.5 percent), and Roane County (13.8 percent). [Text deleted.] In 1995, ORR employed 18,010 persons.

Regional Economy Characteristics. Selected employment and regional economy statistics for the ORR REA are summarized in Figure 3.6.8–1. Between 1980 and 1990, the civilian labor force in the REA increased 16.2 percent to the 1990 level of 412,803. The 1994 unemployment in the REA was 4.9 percent, which was about the same as the unemployment for Tennessee (4.8 percent). The region's per capita income of $17,652 in 1993 was approximately 4.3 percent less than the statewide per capita income of $18,439.

As shown in Figure 3.6.8–1, the composition of the REA economy parallels that of Tennessee. During 1993, the service sector constituted about 26 percent of the region's nonfarm private sector, while retail trade constituted 19 percent. Manufacturing represented about 18 percent of ORR REA employment. In Tennessee, the service sector comprised 26 percent of total employment, manufacturing 19 percent, and retail trade 17 percent.

Population and Housing. In 1994, the ROI population totaled 512,254. From 1980 to 1994, the ROI population grew by 10.4 percent, compared to 12.7 percent growth in Tennessee. Within the ROI, Loudon County experienced the greatest population increase, 22.9 percent, while Roane County's population increased by only 0.2 percent. Population and housing trends are summarized in Figure 3.6.8–2.

The 13.8-percent increase in the number of housing units between 1980 and 1990 for the ROI was nearly 2 percent less than the increase in the number of housing units for the entire State. The total number of housing units in the ROI for 1990 was 206,067. The 1990 ROI homeowner and renter vacancy rates were 1.7 and 8.5 percent, respectively. These rates were comparable to the statewide rates.

Community Services. Education, public safety, and health care characteristics were used to assess the level of community services in the ORR ROI. Figure 3.6.8–3 presents school district characteristics for the ORR ROI. Figure 3.6.8–4 summarizes public safety and health care services.

Education. In 1994, eight school districts provided public education services and facilities in the ORR ROI. As seen in Figure 3.6.8–3, these school districts operated at between 74.7-percent (Harriman School District) and 100-percent (Anderson, Knox, and Loudon Counties) capacity. The average student-to-teacher ratio for the ORR ROI in 1994 was 16.2:1. The Lenoir City School District had the highest ratio at 17.2:1.

Public Safety. City, county, and State law enforcement agencies provided police protection to the residents of the ROI. In 1994, a total of 885 sworn police officers served the four-county area. The city of Knoxville employed the largest number of officers (337), while Anderson County had the highest officer-to-population ratio (3.7 sworn officers per 1,000 persons). The average ROI officer-to-population ratio was 1.7 officers per 1,000 persons. Figure 3.6.8–4 compares police force strengths across the ROI.

Fire protection services in the ORR ROI were provided by 1,120 paid and volunteer firefighters in 1995. The fire district with the highest firefighter-to-population ratio was located in the city of Kingston, 7.1 firefighters per 1,000 persons, as indicated in Figure 3.6.8–4. Knoxville employed the greatest number of firefighters (357). The average firefighter-to-population ratio in the ROI was 2.2 firefighters per 1,000 persons.

Health Care. There were 10 hospitals serving the four-county ROI in 1994. Over 78 percent of the hospital beds capacity was located in six hospitals in Knox County. Figure 3.6.8–4 displays the hospital bed-to-population ratios for the ORR ROI counties. During 1994, all 10 hospitals operated at below capacity, with bed occupancy rates ranging from 32.0 percent in Loudon County to 65.3 percent in Anderson County.

There were 1,306 physicians in the ROI during 1994, with the majority (1,109) practicing in Knox County. Figure 3.6.8–4 shows that the physician-to-population ratios ranged from 0.6 physicians per 1,000 persons in Roane County to 3.1 physicians per 1,000 persons in Knox County. The average ROI physician-to-population ratio was 2.5 physicians per 1,000 persons.

Local Transportation. Interstates and State Routes provide access between ORR and metropolitan areas (see Figure 2.2.5-1 and Figure 2.2.5-2). The east-west highway, Interstate 40, located 3 km (2 mi) south of the reservation boundary, provides access to the cities of Nashville and Knoxville, Tennessee. The north-south highway, Interstate 75, is located 5 km (3 mi) east of ORR and serves as a major route to the south, passing through the cities of Chattanooga, Tennessee, and Atlanta, Georgia.

Vehicular access to ORR is provided by three State Routes. State Route 95 forms an interchange with Interstate 40 and enters the reservation from the south. State Route 58 enters the reservation from the west and passes just south of K–25. State Route 162 extends from Interstate 75 and Interstate 40 just west of Knoxville and provides eastern access to the ORR.

Within ORR, several routes are used to transfer traffic from the State Routes to the main plant areas. Bear Creek Road, located north of Y–12, flows in an east-west direction and connects Scarboro Road on the east end of the plant with State Route 95 and State Route 58. Bear Creek Road has restricted access around Y–12 and is not a public thoroughfare. Bethel Valley Road, a public roadway, extends from the east end of the ORR at State Route 62 to the west end at State Route 95. Blair Road provides access to K–25 from the north.

There are two current road improvement projects affecting access to ORR. The first is the construction of two box bridges on State Route 61 near Oak Ridge. The second is the repavement of State Route 62 from Tuskegee Drive to north of Union Valley Road. There are two planned road improvement projects that could affect access to ORR in the near future. The first is the reconstruction of State Route 9 in Lake City. The second is the construction of State Route 58 from Interstate 40 to State Route 95 in Oak Ridge (TN DOT 1995a:3).

Five road segments in the ROI could be affected by the storage and disposition alternatives. The first is I-275 from I-40 at Knoxville to I-75/640 at Knoxville. This segment operated at level of service D in 1995. The second is I-640 from I-75 at Knoxville to I-40. This segment operated at level of service D in 1995. The third is U.S. 70 from U.S. 321 to U.S. 11. This segment operated at level of service B in 1995. The fourth is Tennessee State Route 58 from Tennessee State Route 95 to I-40. The segment operated at level of service E in 1995. The fifth is Tennessee State Route 62 from Tennessee 95 at Oak Ridge to Tennessee State Route 170. This segment operated at level of service F in 1995.

Two main line branches provide rail service for ORR. The CSX Transportation line at Elza (just east of Oak Ridge) serves the Y–12 Plant and the Office of Science and Technological Information in east Oak Ridge. The Norfolk Southern main line from Blair provides easy access to K–25. The Clinch River has a barge facility located on the west end of ORR near K–25 and is occasionally used for the receipt of shipments that are too large or heavy to be transported by rail or truck. McGhee Tyson Airport, located 37 km (23 mi) from ORR, is the nearest airport serving the region with major carriers providing passenger and cargo service. A private airport, Atomic Airport, Inc., is the closest air transportation facility to Oak Ridge. Oak Ridge has a part-time public transportation system (ORR 1995a:7).

3.6.9 PUBLIC AND OCCUPATIONAL HEALTH AND SAFETY

Radiation Environment. Major sources and levels of background radiation exposure to individuals in the vicinity of ORR are shown in Table 3.6.9–1. Annual background radiation doses to individuals are expected to remain constant over time. The total dose to the population changes as the population size changes. Background radiation doses are unrelated to ORR operations.

Table 3.6.9–1. Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Oak Ridge Reservation Operation

Source	Effective Dose Equivalent (mrem/yr)
Natural Background Radiation[a]	
Cosmic radiation	27
External terrestrial radiation	28
Internal terrestrial radiation	40
Radon in homes (inhaled)	200
Other Background Radiation[b]	
Diagnostic x rays and nuclear medicine	53
Weapons test fall out	<1
Air travel	1
Consumer and industrial products	10
Total	360

[a] OR DOE 1994c.
[b] NCRP 1987a.
Source: Value of radon is an average for the United States.

Releases of radionuclides to the environment from ORR operations provide another source of radiation exposure to individuals in the vicinity of ORR. Types and quantities of radionuclides released from operations in 1993 are listed in the *Oak Ridge Reservation Environmental Report for 1993* (ES/ESH-47). Doses to the public resulting from these releases and direct radiation are presented in Table 3.6.9–2. These doses fall within radiological limits (DOE Order 5400.5) and are small in comparison to background radiation. The releases listed in the 1993 report were used in the development of the reference environment (No Action) radiological releases and resulting impacts at ORR in the year 2005 (Section 4.2.5.9).

Based on a risk estimator of 500 cancer deaths per 1 million person-rem to the public (Section M.2.1.2), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from ORR operations in 1993 is estimated to be 1.5×10^{-6}. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of ORR operations is less than 2 in 1 million. (Note that it takes several to many years from the time of radiation exposure for a cancer to manifest itself.)

Based on the same risk estimator, 0.014 excess fatal cancers are projected in the population living within 80 km (50 mi) of ORR from normal operations in 1993. To place this number into perspective, it can be compared with the number of fatal cancers expected in this population from all causes. The 1990 mortality rate associated with cancer for the entire U.S. population was 0.2 percent per year (Almanac 1993a:839). Based on this national rate, the number of fatal cancers expected to occur during 1993 from all causes was 1,760 for the population living within 80 km (50 mi) of ORR. This number of expected fatal cancers is much higher than the estimated 0.014 fatal cancers that could result from ORR operations in 1993.

Table 3.6.9–2. Radiation Doses to the Public From Normal Oak Ridge Reservation Operation in 1993 (Committed Effective Dose Equivalent)

Members of the General Public	Atmospheric Releases		Liquid Releases		Total	
	Standard[a]	Actual	Standard[a]	Actual	Standard[a]	Actual
Maximally exposed individual (mrem)	10	1.4	4	0.60[b]	100	3.0[c]
Population within 80 km[d] (person-rem)	None	26	None	2.0	100	28.0
Average individual within 80 km[e] (mrem)	None	0.030	None	0.0023	None	0.032

[a] The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10 mrem/yr limit from airborne emissions is required by the CAA, the 4 mrem/yr limit is required by the SDWA, and the total dose of 100 mrem/yr is the limit from all pathways combined. The 100 person-rem value for the population is given in proposed 10 CFR 834 (58 FR 16268). If the potential total dose exceeds this value, it is required that the contractor operating the facility notify DOE.

[b] These doses are mainly from drinking water and eating fish from the Clinch River section of Poplar Creek.

[c] This total dose includes 1 mrem/yr from direct radiation exposure to a cesium field near the Clinch River.

[d] In 1993, this population was approximately 880,000.

[e] Obtained by dividing the population dose by the number of people living within 80 km of the site.

Source: OR DOE 1994c.

Oak Ridge Reservation workers receive the same dose as the general public from background radiation, but also receive an additional dose from working in the facilities. Table 3.6.9–3 presents the average worker, maximally exposed worker, and cumulative worker dose to ORR workers from operations in 1992. These doses fall within radiological regulatory limits (10 CFR 835). Based on a risk estimator of 400 fatal cancers per 1 million person-rem among workers (Section M.2.1.2), the number of fatal cancers to ORR workers from normal operations in 1992 is estimated to be 0.027.

Table 3.6.9–3. Radiation Doses to Workers From Normal Oak Ridge Reservation Operation in 1992 (Committed Effective Dose Equivalent)

Occupational Personnel	Onsite Releases and Direct Radiation	
	Standard[a]	Actual
Average worker (mrem)	ALARA	4.0
Maximally exposed worker (mrem)	5,000	2,000
Total workers[b] (person-rem)	ALARA	68

[a] DOE's goal is to maintain radiological exposures as low as reasonably achievable.

[b] The number of badged workers in 1992 was approximately 17,150.

Source: 10 CFR 835; DOE 1993n:7.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the *Oak Ridge Reservation Environmental Report for 1993* (ES/ESH-47). The concentrations of radioactivity in various environmental media (including air, water, and soil) in the site region (onsite and offsite) are also presented in the same report.

Chemical Environment. The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (for example, surface waters during swimming and soil through direct contact or via the food pathway). The baseline data for assessing potential health impacts from the chemical environment are those presented in previous sections of this PEIS, particularly Section 3.6.3.

Effective administrative and design controls that decrease hazardous chemical releases to the environment and help achieve compliance with permit requirements (for example, air emissions and NPDES permit requirements) contribute toward minimizing potential health impacts to the public. The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts to the public may occur during normal operations via inhalation of air containing hazardous chemicals released to the atmosphere by ORR operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water or direct exposure, are low relative to the inhalation pathway.

Baseline air emission concentrations for hazardous chemicals and their applicable standards are included in the data presented in Section 3.6.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are in compliance with applicable guidelines and regulations. Information about estimating health impacts from hazardous chemicals is presented in Section M.3.

Exposure pathways to ORR workers during normal operations may include inhaling the workplace atmosphere and direct contact with hazardous materials associated with work assignments. The potential for health impacts varies from facility to facility and from worker to worker, and available information is not sufficient to allow a meaningful estimation and summation of these impacts. However, workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. ORR workers are also protected by adherence to OSHA and EPA standards that limit workplace atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring that reflects the frequency and amounts of chemicals utilized in the operational processes ensures that these standards are not exceeded. Additionally, DOE requirements (DOE O 440.1) ensure that conditions in the workplace are as free as possible from recognized hazards that cause or are likely to cause illness or physical harm. Therefore, worker health conditions at ORR are expected to be substantially better than required by the standards.

Health Effects Studies. Two epidemiologic studies were conducted to determine whether ORR contributed to any excess cancers in communities surrounding the facility. One study found no excess cancer mortality in the population living in counties surrounding ORR when compared to the control populations located in other nearby counties and elsewhere in the United States. The other found slight excess cancer incidences of several types in the counties near ORR, but none of the excess risks were statistically significant.

A pilot study on mercury contamination conducted by the Tennessee Department of Health and Environment showed no difference in urine or hair mercury levels between individuals with potentially high mercury exposures compared to those with little potential for exposure. However, soil analysis showed that the mercury in soil was inorganic, which decreases the likelihood of bioaccumulation and health effects. Studies are continuing on the long-term effects of exposure to mercury and other hazardous chemicals.

More epidemiologic studies have been conducted to assess the health effect of the population working at ORR than any other site reviewed for this document. Excess cancer mortalities have been reported and linked to specific job categories, age, and length of employment, as well as to the levels of exposure to radiation. For a more detailed description of the studies reviewed and the findings, refer to Section M.4.6.

Accident History. There have been no accidents with a measurable impact on offsite population during nearly 50 years of Y–12 operations at ORR. The most noteworthy accident in Y–12 history was a 1958 criticality accident. The impact from this accident resulted in temporary radiation sickness for a few ORR employees. In 1989, there was a one-time accidental release of xylene into the ORR sewer system with no offsite impacts.

Accidental releases of anhydrous hydrogen fluoride occurred in 1986, 1988, and 1992, with little onsite and negligible offsite impacts. The hydrogen fluoride system where these accidents occurred is being modified to reduce the probability of future releases and to minimize the potential consequences if a release does occur (ORR 1992a:6).

Emergency Preparedness. Each DOE site has established an emergency management program that would be activated in the event of an accident. This program has been developed and maintained to ensure adequate response for most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program incorporates activities associated with emergency planning, preparedness, and response.

The Department has overall responsibility for emergency planning and operations at ORR. However, DOE has delegated primary authority for event response to the operating contractor. Although the contractor's primary response is onsite, the contractor does provide offsite assistance if requested under the terms of existing mutual aid agreements. If a hazardous materials event with offsite impacts occurs at a DOE ORR facility, elected officials and local governments are responsible for the State's response efforts. The Governor's Executive Order No. 4 established the Tennessee Emergency Management Agency as the agency responsible for coordinating State emergency services. When a hazardous materials event occurring at DOE facilities is beyond the capability of local government, and assistance is requested, the Tennessee Emergency Management Agency Director may direct State agencies to provide assistance to the local governments. To accomplish this task and ensure prompt initiation of emergency response actions, the Director may cause the State Emergency Operations Center and Field Coordination Center to be activated. City or county officials may activate local Emergency Operations Centers in accordance with existing emergency plans.

3.6.10 WASTE MANAGEMENT

This section outlines the major environmental regulatory structure and ongoing waste management activities for ORR. A more detailed discussion of the ongoing waste management operations is provided in Section E.2.5. Tables 3.6.10–1 (Y–12), 3.6.10–2 (ORNL), and 3.6.10–3 (K–25) present a summary of waste management activities at ORR for 1994.

The Department is working with Federal and State regulatory authorities to address compliance and cleanup obligations arising from its past operations at ORR. DOE 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.

The EPA placed ORR on the NPL on November 21, 1989. DOE, EPA Region IV, and the TDEC completed a Federal Facility Agreement effective January 1, 1992. This agreement coordinates ORR inactive site assessment and remedial action. Portions of the Federal Facility Agreement are applicable to operating waste management systems. Existing actions are conducted under RCRA and applicable State laws, which minimize duplication, expedite response actions, and achieve a comprehensive remediation of the site. ORR generates and manages spent nuclear fuel and the following waste categories: TRU, low-level, mixed, hazardous, and nonhazardous. A discussion of the waste management operations associated with each of these categories follows.

Spent Nuclear Fuel. The ORR generates and manages a relatively small quantity of spent nuclear fuel. The only operating reactor is the ORNL High-Flux Isotope Reactor, which is used to produce isotopes for medical and industrial applications, neutron scattering experiments, and various materials irradiation experiments. ORR has also received some offsite shipments of reactor irradiated nuclear material. Most of the fuel and irradiated nuclear material is stored in numerous buildings and hot cells at ORNL and one building at Y–12. Some of the fuel still remains in the core of the inactive research reactors. Irradiated fuel and its associated fission products are stored in dry wells at ORNL in Solid Waste Storage Area-5N. A small amount of irradiated spent nuclear fuel is stored in wells and trenches in Solid Waste Storage Areas-5S and -6. The interim management of the spent nuclear fuel will be in accordance with the ROD published in the *Federal Register* (60 FR 28680) on June 1, 1995, for the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE/EIS-0203-F) as amended on March 8, 1996 (61 FR 9441).

High-Level Waste. The ORR does not generate or manage HLW.

Transuranic Waste. The ORNL is the only generator of TRU waste at ORR. Solid TRU waste consisting of filters, paper, metals, and other items was generated at ORNL through laboratory, pilot plant, and reactor operations. This includes both contact-handled and remote-handled TRU waste contaminated with lead and, in some cases, mercury. Contact-handled waste is TRU waste that contains mainly Pu, which emits alpha particles and low-energy photons. The packaging is designed to provide sufficient containment and shielding to minimize personnel exposure. Remote-handled TRU waste contains activation materials and fission products that decay and emit beta and gamma radiation on the surface of the packaging that exceeds 200 mrem/hr.

As of December 31, 1994, approximately 1,360 m^3 (1,790 yd^3) of TRU wastes were in retrievable drum storage. The amount of remote-handled waste was about 1,420 m^3 (1,860 yd^3) (OR LMES 1996a:4-4b). Current activities center around certification of contact-handled waste, planning/designing of a repackaging and certification facility for remote-handled wastes, and planning for shipment of wastes to a suitable repository that can provide for the disposal of TRU wastes.

Low-Level Waste. Solid LLW, consisting primarily of radioactively-contaminated construction debris, wood, paper, asbestos, trapping media, personnel protection equipment, process equipment, and radioactive materials

Table 3.6.10–1. Spent Nuclear Fuel and Waste Management Activities at Oak Ridge Reservation, Y–12 Plant

Category	1994 Generation (m^3)	Treatment Method	Treatment Capacity (m^3/yr)	Storage Method	Storage Capacity (m^3)	Disposal Method	Disposal Capacity (m^3)
Spent Nuclear Fuel	None	NA	NA	Storage vaults[a]	4[b]	None-Ship to INEL or SRS	NA
Low-Level							
Liquid	898	Activated sludge	12,900[c]	Stored onsite	Included in liquid mixed LLW	NA	NA
Solid	5,230[d]	Stabilization and compaction, incineration and smelting by commercial vendor	19,300[e]	Stored onsite at Y–12 or K–25	16,200[f]	None—stored pending availability of offsite disposal or planned onsite LLW disposal facilities	NA
Mixed Low-Level							
Liquid	1,390	Neutralization, activated sludge, oxidation, adsorption, and incineration at K–25	12,300[g]	Tanks and drums	2,660[h]	NA	NA
Solid	306	Incineration at K–25 or offsite commercial vendors	NA	Staged for shipment	11,700[i]	Offsite	NA
Hazardous							
Liquid	9,450	Managed as mixed LLW	30,300[j]	Tanks	751[k]	Offsite	NA
Solid	Included in hazardous liquid[l]	None	NA	Staged for shipment	170[m]	Offsite	NA
Nonhazardous (Sanitary)							
Liquid	2,460 m^3/day[n]	Offsite[o]	5,300 m^3/day	None	NA	Offsite	NA
Solid	41,700[p]	Compaction	41,700[q]	None	NA	Industrial and Sanitary Landfill V, offsite at municipal site	1,100,000[r]

Table 3.6.10–1. Spent Nuclear Fuel and Waste Management Activities at Oak Ridge Reservation, Y–12 Plant—Continued

Category	1994 Generation (m^3)	Treatment Method	Treatment Capacity (m^3/yr)	Storage Method	Storage Capacity (m^3)	Disposal Method	Disposal Capacity (m^3)
Nonhazardous (Other)							
Liquid	228,000[s]	Evaporation, neutralization, and precipitation	251,000[t]	None	NA	Offsite-NPDES outfall	NA
Solid	Included in solid sanitary	None	NA	None	NA	Construction Demolition Landfill VI	119,000[r]

[a] Building 9720-5.

[b] Based on conversion factor of 52 kg/m^3(DOE 1995kk). [Text deleted.]

[c] West End Treatment Facility and Central Pollution Control Facility.

[d] Includes 2,500 m^3 of contaminated scrap metal.

[e] Waste Feed Preparation Facility and the Uranium Chip Oxidizer Facility (design feed rate).

[f] Includes the Depleted Uranium Oxide Storage Vaults, Above Grade Storage Facility, salvage yard, Sludge Basin and the Containerized Waste Storage Area.

[g] Includes Waste Coolant Processing Facility, Acid Waste Neutralization and Recovery Facility, Cyanide Treatment Facility, and Groundwater Treatment Facility. The West End Treatment Facility, the Plating Rinsewater Treatment Facility, and the Central Pollution Control Facility can process mixed waste and LLW.

[h] OD7, OD8, OD9, and OD10, Liquid Storage Facility, 9212 Tank Farm, and Building 9720-9 (western half).

[i] RCRA and PCB Container Storage Area (9720-58), Container Storage Facility (Bldg. 9720-12), PCB Drum Storage Facility (9404-7), Buildings (9201-4, 9206, and 9212), and the West End Tank Farm.

[j] Plating Rinsewater Treatment Facility and Stream Plant Wastewater Treatment Facility.

[k] Building 9720-9 (eastern half).

[l] Currently, all RCRA-hazardous wastes are stored at the Y–12 plant or the K–25 Site awaiting further disposal.

[m] RCRA Storage and Staging Area (Bldg. 9720-31).

[n] Storm runoff does not include sewage waste.

[o] Oak Ridge Sewage Treatment Plant.

[p] Includes trash, debris, scrap metal, treatment residue, and classified waste.

[q] The 1994 generation rate was used as an estimate for the capacity of the Building 9720-25 Baler Facility.

[r] Serves all three sites. Value provided is design capacity. Projected utilization is 39,600 m^3/yr for Industrial and Sanitary Landfill V and 27,500 m^3/yr for Construction Demolition Landfill VI.

[s] Includes industrial wastes such as oils and solvents, liquid waste and wastewater from Y–12 Plant operations, contractors and waste management.

[t] Approximate Central Pollution Control Facility, West End Treatment Facility, and Steam Plant Wastewater Treatment Facility NPDES permit annual discharge volume limits for East Fork Poplar Creek.

Note: NA=not applicable.

Source: DOE 1994d; DOE 1994n; DOE 1995gg; DOE 1995kk; OR DOE 1992c; OR DOE 1995g; OR LMES 1996a; OR MMES 1995c; ORR 1993a:4.

Table 3.6.10–2. Spent Nuclear Fuel and Waste Management Activities at Oak Ridge National Laboratory

Category	1994 Generation (m^3)	Treatment Method	Treatment Capacity (m^3/yr)	Storage Method	Storage Capacity (m^3)	Disposal Method	Disposal Capacity (m^3)
Spent Nuclear Fuel	2[a]	None	NA	Pools	53[b]	None-Ship to INEL or SRS	NA
Transuranic (Solid)							
Contact handled	103[c]	None	NA	Staged for shipment[d]	1,760	None, WIPP or alternate facility in future	NA
Remote handled	64	None	NA	Staged for shipment[e]	856	None, WIPP or alternate facility in future	NA
Low-Level							
Liquid	2,070	Ion exchange, filtration, evaporation, and solidification	390,000[f]	Stored onsite in tanks	3,230[g]	NA	NA
Solid	1,640[h]	Compaction (compaction, incineration and smelting by commercial vendor)	11,300[i]	Stored onsite	7,850[j]	Onsite	3,590[k]
Mixed Low-Level							
Liquid	Included in solid mixed LLW[l]	Incineration at K–25	Offsite	Tank and drums	393[m]	None	NA
Solid	92[n]	Incineration at K–25 or offsite commercial vendors	Offsite	Staged for shipment	Include in liquid mixed LLW	Offsite	NA
Hazardous							
Liquid	23,800[o]	Neutralization/ sedimentation and evaporation, treat offsite[p]	Included in nonhazardous (other) liquid capacity	Staged for shipment	Included in solid hazardous	Offsite	NA
Solid	55[p]	Open-burning[q], treat offsite	Variable	Staged for shipment	130[r]	Storage/incineration (K–25) and landfill (Y–12)	NA

Table 3.6.10–2. Spent Nuclear Fuel and Waste Management Activities at Oak Ridge National Laboratory—Continued

Category	1994 Generation (m^3)	Treatment Method	Treatment Capacity (m^3/yr)	Storage Method	Storage Capacity (m^3)	Disposal Method	Disposal Capacity (m^3)
Nonhazardous (Sanitary)							
Liquid	360,000	Extended aeration-activated sludge treatment	414,000[s]	None	NA	NPDES outfall	NA
Solid	4,820	None[t]	NA	None	NA	Y–12 landfill, offsite to municipal site	See Table 3.6.10–1
Nonhazardous (Other)							
Liquid	718,000[u]	Neutralization, precipitation, and filtration	1,510,000[v]	None	NA	Offsite	NA
Solid	Included in solid sanitary	None	NA	None	NA	Y–12 landfill and SWSA 6 burial	Included in sanitary

[a] The HFIR research reactor generates 12 fuel assemblies per year (9.4 kg U-235 per assembly). Based on conversion factor of 52 kg/m^3 (DOE 1995kk).

[b] Includes 820 kg of available spent fuel capacity at the HFIR pool (43% full). Reracking of positions under way. Based on conversion factor of 52 kg/m^3, and the size of all fuel elements is assumed to be the same (DOE 1995kk).

[c] Does not include 8 m^3 of mixed TRU waste.

[d] Stored in various buildings (Bldg. 7826, 7834, 7842, 7878, 7879, and 7934).

[e] Stored in tanks, bunkers, and earthen trenches (Bldg. 7855 and SWSA 5N trenches).

[f] Process Waste Treatment Plant, Melton Valley Low-Level Waste Immobilization Facility and Liquid Low-Level Waste Evaporation Facility.

[g] Liquid LLW System.

[h] Includes radioactive scrap metal.

[i] Waste Compaction Facility (Bldg. 7831).

[j] As of June 30, 1995.

[k] Interim Waste Management Facility.

[l] May include 19 m^3 of mixed waste oil treated at TSCA incinerator in 1994.

[m] Buildings 7654, 7507W, 7823 and Tank 7830a.

[n] Includes waste oils, organic wastes, carcinogenic wastes, mercury-contaminated solid wastes, solvents, corrosives, poisons, and other process wastes.

[o] Projected Steam Plant regenerate in 1994 (may be coal yard runoff).

[p] Includes PCB and asbestos. May include some liquid hazardous waste.

[q] The Chemical Detonation Facility treats small amounts of hazardous waste that would be dangerous to transport offsite. Explosives such as aged picric acid are detonated in this facility.

[r] Hazardous Waste Storage Facility (Bldg. 7652 Part B permit - 57,200 l and Bldg. 7507 Part A permit - 31,200 l), and Buildings 7651 and 7653.

[s] Sanitary Waste Water Treatment Facility design capacity.

[t] Loaded in boxes and stored at Interim Waste Management Facility.

[u] May include coal yard runoff which is hazardous waste.

[v] Nonradiological Wastewater Treatment Facility.

Note: NA=not applicable.

Source: DOE 1993s; DOE 1994d; DOE 1994n; DOE 1995gg; DOE 1995kk; OR DOE 1993b; OR DOE 1995g; OR LMES 1996a; OR MMES 1995c.

Table 3.6.10–3. Waste Management Activities at Oak Ridge Reservation, K–25 Site

Category	1994 Generation (m^3)	Treatment Method	Treatment Capacity (m^3/yr)	Storage Method	Storage Capacity (m^3)	Disposal Method	Disposal Capacity (m^3/yr)
Low-Level							
Liquid	55	Incineration	15,700[a]	Stored onsite	Included in solid LLW[b]	NA	NA
Solid	4,480[c]	Compaction/ incineration and smelting by commercial vendor	Offsite	Stored onsite	44,000[d]	None–stored pending availability of offsite disposal or planned onsite LLW disposal facilities	NA
Mixed Low-Level							
Liquid	148,000[e]	Neutralization and incineration	221,000[f]	Stored onsite	97,000[g]	NA	NA
Solid	222[h]	Incineration or offsite by commercial vendors	Offsite[i]	Stored onsite	120,000[j]	Offsite	1,130[k]
Hazardous							
Liquid	Included in liquid mixed low-level[l]	Treated as mixed LLW	Included in liquid mixed LLW	Treated as mixed LLW	Included in liquid mixed LLW	Offsite	NA
Solid	743[m]	Treated as mixed LLW	Offsite[n]	Treated as mixed LLW	Included in solid mixed LLW	Offsite	NA
Nonhazardous (Sanitary)							
Liquid	416,000	Extended aeration	829,000 - sewage[o]	None	NA	NPDES outfall	NA
Solid	2,950[p]	None	NA	None	NA	Oak Ridge landfill (offsite)	NA

Table 3.6.10–3. Waste Management Activities at Oak Ridge Reservation, K–25 Site—Continued

Category	1994 Generation (m^3)	Treatment Method	Treatment Capacity (m^3/yr)	Storage Method	Storage Capacity (m^3)	Disposal Method	Disposal Capacity (m^3/yr)
Nonhazardous (Other)							
Liquid	69,300[q]	Neutralization settling; and filtration	221,000[r]	None	NA	NPDES outfall	NA
Solid	Included in solid sanitary	None	NA	Stockpiled at scrap yard	Unspecified capacity	Y–12 landfill and metal sold to public	See Table 3.6.10–1

[a] TSCA Incinerator (K-1435). Also treats mixed waste.
[b] Liquid LLW stored in Building K–25 vaults.
[c] Includes 103 m^3 of contaminated scrap metal.
[d] Based on solid LLW stored in Building K–25, outside areas, K-1313A, and K-33.
[e] Includes TSCA waste waters and density assumption is equal to 1 kg/l.
[f] Central Neutralization Facility permitted operating capacity.
[g] Includes current permitted container (solid/sludges/liquid wastes) and tank (liquids) storage capacity.
[h] Includes contaminated asbestos/beryllium oxide (BeO), RCRA and state regulated waste, and may include some PCB-tainted waste.
[i] Sludge Fixation Facility may be used after engineering problems are solved.
[j] Total current permitted waste pile unit storage capacity.
[k] Waste sent to commercial vendor in 1994.
[l] Hydrogen softener blowdown from the steam plant.
[m] Managed as mixed waste.
[n] Sludge Fixation Facility may be used after engineering problems are solved
[o] Sewage treatment plant capacity (Bldg. K-1203).
[p] Includes waste shipped to Y–12 Sanitary Landfill.
[q] Includes nonhazardous Steam Plant waste water.
[r] Central Neutralization Facility permitted capacity.
Note: NA=not applicable.
Source: DOE 1995gg; OR DOE 1993a; OR LMES 1996a; ORR 1993a:4.

removed from liquid and airborne discharges, is generated at ORR. ORNL operates the only LLW disposal facility at ORR. This disposal facility only accepts LLW generated at ORNL. Solid LLW is being stored at K–25 and Y–12 for future disposal. Contaminated scrap metal is stored above ground at the K-770 scrap metal facility and the Y–12 old salvage yard until further disposal methods are evaluated.

The management of LLW at ORR has been affected by three recent events: declines in ORR disposal capacity, changes in regulatory and operational conditions, and evolution of the radioactive waste disposal-class concept. The previous strategy classified LLW according to its isotopic content, concentration, and the performance of a disposal facility. In some instances, these classifications are used to describe the type of LLW or a disposal technology. For example, L-I refers to low concentration LLW or a landfill disposal facility, while L-II refers to low to moderate concentration LLW or a tumulus disposal facility. A revised classification system has been proposed. Exempt LLW would have contaminant levels sufficiently low to be disposed of in a sanitary or industrial landfill with State concurrence. Disposable LLW would be suitable for disposal on the ORR as determined by facility performance assessments. Offsite LLW would be that LLW which would not meet the criteria of exempt or disposable. The long-range strategy is to rely on the combination of onsite and offsite facilities. Plans for a replacement onsite disposal facility will continue to be pursued with the most likely candidate site for a tumulus disposal facility being Bear Creek Valley. That portion of the LLW that cannot be disposed of onsite consistent with DOE Order 5820.2A, *Radioactive Waste Management*, will be stored until disposal offsite becomes available.

Mixed Low-Level Waste. The RCRA mixed, radioactive land disposal restricted waste is in storage at Y–12, K–25, and ORNL. Because prolonged storage of these wastes exceeded the one-year limit imposed by RCRA, ORR entered into a Federal Facility Compliance Agreement (FFCA) for RCRA Land Disposal Restriction wastes with EPA on June 12, 1992. This agreement was terminated with issuance of the TDEC Commissioner's Order, effective October 1, 1995, which requires DOE to comply with the Site Treatment Plan prepared by ORR. The plan contains milestones and target dates for DOE to characterize and treat its inventory of mixed wastes at ORR.

Sludges contaminated with low-level radioactivity are generated by settling and scrubbing operations, and in the past were stored in K-1407-B and 1407-C ponds at K–25. Sludges have been removed from these ponds and a portion has been fixed in concrete at the K-1419 Sludge Treatment Facility and stored at the K-33 Building. The concreted sludges are being shipped offsite for disposal. The raw sludges are stored in the in the K–1065 building pending further treatment. Mixed waste sludges are also generated at Y–12 in the treatment of nitrate waste from purification and recycling of uranium and in the treatment of plating shop waste.

The primary facility generator of liquid mixed waste is the K-1435 TSCA Incinerator from the wet scrubber blowdown. This waste is currently being treated at the Central Neutralization Facility, which provides pH adjustment and chemical precipitation. Treated effluents are discharged through an NPDES outfall. The contaminated sludges are stored at K–25 as mixed waste.

The K–25 TSCA incinerator has a design capacity to incinerate 909 kg/hr (2,000 lb/hr) of mixed liquid waste and up to 455 kg/hr (1,000 lb/hr) of solids and sludge (91 kg/hr [200 lb/hr] maximum sludge content) (ORR 1993a:2). The TSCA incinerator is capable of incineration of both TSCA- and RCRA-mixed wastes. DOE guidance currently does not allow incineration of solids/sludges. Because of permit limits (TSCA, RCRA, State of Tennessee), the incinerator is not running at full capacity. In 1994, approximately 2,590 m^3 (683,000 gals) of mixed liquid waste was incinerated (OR LMES 1996a:7-6).

Uranium wastes contaminated with PCBs (that is, mixed wastes) are being stored in excess of the 1-year limit imposed by TSCA because of the lack of treatment and disposal capacities. DOE and EPA have signed an FFCA, effective February 20, 1992, to bring K–25 associated with the Uranium Enrichment Program into compliance with TSCA regulations for use, storage, and disposal of PCBs. It also addressed the approximately 10,000 pieces of nonradioactive PCB-containing dielectric equipment associated with the shutdown of diffusion plant operations. An additional FFCA related to TSCA compliance is currently being discussed by DOE and EPA for ORR.

Hazardous Waste. The RCRA-regulated waste are generated by ORR in laboratory research, electroplating operations, painting operations, descaling, demineralizer regeneration, and photographic processes. Certain other wastes (for example, spent photographic processing solutions) are processed onsite into a nonhazardous state. Those wastes that are safe to transport and have been certified as having no radioactivity added are shipped offsite to RCRA-permitted commercial treatment and disposal facilities. Small amounts of reactive chemical explosives that would be dangerous to transport offsite, such as aged picric acid, are processed onsite in the Chemical Detonation Facility at ORNL.

Nonhazardous Waste. Nonhazardous wastes are generated from ORR maintenance and utilities. For example, the steam plant produces nonhazardous sludge. Scrap metals are discarded from maintenance and renovation activities and are recycled when appropriate. Construction and demolition projects also produce nonhazardous industrial wastes. All nonradioactive medical wastes are autoclaved to render them noninfectious and are sent to the Y–12 Sanitary Landfill. Remedial action projects also produce wastes requiring proper management. The State of Tennessee permitted landfill (Construction Demolition Landfill VI) receives nonhazardous industrial materials such as fly ash and construction debris. Asbestos and general refuse are managed in Industrial and Sanitary Landfill V located at Y–12.

3.7 SAVANNAH RIVER SITE

The SRS is located approximately 19 km (12 mi) south of Aiken, South Carolina (see Figure 2.2.6–1). First established in 1950, SRS has been involved for more than 40 years in tritium operations and other nuclear material production. Today the site includes 16 major production, service, research, and development areas, not all of which are currently in operation.

There are more than 3,000 facilities at SRS, including 740 buildings with 511,000 m^2 (5,500,000 ft^2) of floor area. Major nuclear facilities at SRS include fuel and Pu storage facilities and target fabrication facilities, nuclear material production reactors, chemical separations plants, a uranium fuel processing area, liquid HLW tank farms, a waste vitrification facility, and the Savannah River Technology Center. SRS processes nuclear materials into forms suitable for continued safe storage, use, or transportation to other DOE sites. In accordance with the ROD for the *F-Canyon Plutonium Solutions Environmental Impact Statement* (60 FR 9824), and the *Environmental Impact Statement, Interim Management of Nuclear Materials* (60 FR 65300 and 61 FR 6633) Pu solutions have been stabilized and targets have been dissolved and processed in the F-Canyon. A second supplemental ROD announcing DOE's decision for the stabilization of Pu-239 solutions by conversion to metal at F-Canyon and the FB-Line was published September 13, 1996 (61 FR 48474). Tritium recycling facilities at SRS empty tritium from expired reservoirs, purify it to eliminate the helium decay product, and fill replacement reservoirs with specification tritium for nuclear stockpile weapons. Filled reservoirs are delivered to Pantex for weapons assembly and directly to DoD to replace expired reservoirs. Historically, DOE has produced tritium at SRS, but has not produced any since 1988.

Department of Energy Activities. The current missions at SRS are shown in Table 3.7–1. [Text deleted.] In the past, the SRS complex produced nuclear materials. The complex consisted of various Pu storage facilities, five reactors (the C-, K-, L-, P-, and R-Reactors) (all inactive), a fuel and target fabrication plant, two chemical separation plants, a tritium-target processing facility, a heavy water rework facility, and waste management facilities. The K-Reactor (the last operational reactor) has been shut down with no planned provision for restart. SRS is still conducting tritium recycling operations in support of stockpile requirements using retired weapons as the tritium supply source. The Separations Facilities, and the F- and H-Canyons, are planned to be used through the year 2002 to complete DOE's commitment to the DNFSB regarding stabilization of site inventories of legacy nuclear materials.

The DOE Office of Environmental Management is pursuing a 30-year plan to achieve full compliance with all applicable laws, regulations, and agreements to treat, store, and dispose of existing wastes; reduce generation of new wastes; clean up inactive waste sites; remediate contaminated groundwater; and dispose of surplus facilities.

The Savannah River Technology Center provides technical support to all DOE operations at SRS. In this role, it provides process engineering development to reduce costs, waste generation, and radiation exposure. SRS has an expanding mission to transfer unique technologies developed at the site to industry. SRS is also an active participant in the Strategic Environmental R&D Program formulated to develop technologies to mitigate environmental hazards at DoD and DOE sites.

Non-Department of Energy Activities. Non-DOE facilities and operations at SRS include the Savannah River Forest Station, the Savannah River Ecology Laboratory, and the Institute of Archaeology and Anthropology. The Savannah River Forest Station is an administrative unit of the U.S. Forest Service, which provides timber management, research support, soil and water protection, wildlife management, secondary roads management, and fire management to DOE. The Savannah River Forest Station manages 62,300 ha (154,000 acres), comprising approximately 80 percent of the site area. It has been responsible for reforestation and manages an active timber business. The Savannah River Forest Station assists with the development and updating of sitewide land use and provides continual support with site layout and vegetative management. It also assists in long-term wildlife management and soil rehabilitation projects.

Table 3.7–1. Current Missions at Savannah River Site

Mission	Description	Sponsor
Pu storage	Maintain F-Area Pu storage facilities	Assistant Secretary for Environmental Management
Tritium recycling	Operate H-Area tritium facilities	Assistant Secretary for Defense Programs
Stabilize targets, spent nuclear fuels, and other nuclear materials	Operate F- and H-Canyons	Assistant Secretary for Environmental Management
Waste management	Operate waste processing facilities	Assistant Secretary for Environmental Management
Environmental monitoring and restoration	Operate remediation facilities	Assistant Secretary for Environmental Management
Research and development	Savannah River Technology Center technical support of DP, EM, and Nuclear Energy programs	Assistant Secretary for Defense Programs; Assistant Secretary for Environmental Management; Office of Nuclear Energy
Other non-DOE missions	Various, as described in text	Various

Source: SRS 1995a:2.

The Savannah River Ecology Laboratory is operated for DOE by the Institute of Ecology of the University of Georgia. It has established a center of ecological field research where faculty, staff, and students perform interdisciplinary field research and provide an understanding of the impact of energy technologies on the ecosystems of the southeastern United States. This information is communicated to the scientific community, government agencies, and the general public. In addition to Savannah River Ecology Laboratory studies, the Institute of Archaeology and Anthropology is operated by the University of South Carolina to survey the archaeological resources of SRS. These surveys are used by DOE when planning new facility additions or modifications, and are used as reference documents by site management.

3.7.1 LAND RESOURCES

Land Use. The SRS occupies approximately 80,130 ha (198,000 acres) in portions of Aiken, Barnwell, and Allendale Counties in southwestern South Carolina, approximately 40 km (25 mi) southeast of Augusta, Georgia (SR DOE 1995e:5-11). All of the land within SRS is owned by the Federal Government and is administered, managed, and controlled by DOE.

Existing Land Use. Generalized existing land uses at SRS and in the vicinity are shown in Figure 3.7.1–1. SRS land use can be grouped into three major categories: forest/undeveloped, water, and developed facility locations. Forest/undeveloped lands (for example, open fields and pine or hardwood forests) make up approximately 58,500 ha (144,500 acres) or 73 percent; water (for example, wetlands, streams, and lakes) comprising approximately 17,600 ha (43,500 acres) or 22 percent; and developed facility (for example, production and support areas, roads, and utility corridors) accounts for approximately 4,000 ha (9,900 acres) or 5 percent of the total land area of SRS. A forest management program has been in effect at SRS since 1952, when it was formed through an interagency agreement between DOE, then the AEC, and the U.S. Forest Service (WSRC 1993a:317). The majority of the woodlands area is in revenue producing, managed timber production. Soil map units that meet the soil requirements for prime farmland soils exist on SRS. However, U.S. Department of Agriculture, Natural Resources Conservation Service does not identify these lands as prime farmland due to the nature of site use (that is, the lands are not available for the production of food or fiber) (SR USDA 1995a:1).

In 1972, DOE designated the entire SRS as a NERP. The NERP is used by the national scientific community to study the impact of human activities on the cypress swamp and southeastern pine and hardwood forest ecosystems (DOE 1985a:1).

Land use bordering SRS is primarily forest and agricultural, although there is a substantial amount of open water and nonforested wetland along the Savannah River Valley. Incorporated and industrial areas are the only other significant land uses in the vicinity. There is a small amount of urban and residential development bordering SRS. The closest residences include several located to the west, north, and northeast that are within 61 m (200 ft) of the site boundary.

Land-Use Planning. Through Act 489, as amended in 1994, the State of South Carolina requires local jurisdictions (that is, counties and cities) to undertake comprehensive planning. Regional-level planning also occurs within the State, with the State divided into 10 planning districts guided by regional advisory councils. The councils provide technical planning assistance to local jurisdictions at their request. SRS is located within the counties of Aiken, Allendale, and Barnwell, which together constitute part of the Lower Savannah River Council of Governments (SR RCG 1995a:1).

Visual Resources. The SRS landscape is characterized by wetlands and upland hills. The vegetation is composed of bottomland hardwood forests, scrub oak and pine woodlands, and wetland forests. DOE facilities are scattered throughout SRS and are brightly lit at night. The developed areas and utility corridors (transmission lines and aboveground pipelines) of SRS are consistent with a BLM VRM Class 5 designation. The remainder of SRS generally ranges from VRM Class 3 to Class 4 designation.

The viewshed consists mainly of agricultural and heavily forested land, with some limited residential and industrial areas. Views are limited by rolling terrain, normally hazy atmospheric conditions, and heavy vegetation. DOE facilities are generally not visible from offsite. The only areas with visual sensitivity levels that are presently impacted by DOE facilities are the view corridors of State Highway 125 and SRS Road 1. The few other areas that have views of SRS facilities are quite distant (8 km [5 mi] or more) and have low visual sensitivity levels.

3.7.2 SITE INFRASTRUCTURE

Baseline Characteristics. The SRS contains extensive production, service, and research facilities. Not all of these facilities are in operation or needed today. To support current missions and functions, an extensive infrastructure exists, as shown in Table 3.7.2–1. Pu is currently stored in two vaults within the FB-line and three vaults in the 235-F Facility. Under No Action, APSF will be constructed to provide consolidated storage of all SRS nuclear materials. The road infrastructure is used for extensive intrasite transportation requirements. The railroad infrastructure is used to support large volume deliveries of coal and oversized structural components. SRS does not have a connection to the local natural gas lines.

Table 3.7.2–1. Savannah River Site Baseline Characteristics

Characteristics	Current Usage	Site Availability
Transportation		
Roads (km)	230	230
Railroads (km)	103	103
Electrical		
Energy consumption (MWh/yr)	659,000	1,672,000
Peak load (MWe)	130	330
Fuel		
Natural gas (m^3/yr)	0	0
Oil (l/yr)	28,400,000	28,400,000
Coal (t/yr)	210,000	244,000
Steam (kg/hr)	748,440,000	748,440,000

Source: SRS 1993a:3.

The electrical power infrastructure is of critical importance to the proposed actions involving construction of new facilities. The sub-regional electrical power pool area in which SRS is located and from which it draws its power is the Virginia-Carolina Sub-Region, a part of the Southeastern Electric Reliability Council. SRS draws its electrical power predominately from coal-fired plants and from 17 nuclear-powered generating plants. Characteristics of this power pool are given in Table 3.7.2–2.

Table 3.7.2–2. Virginia-Carolinas Sub-Regional Power Pool Electrical Summary

Characteristics	Energy Production
Type Fuel[a]	
Coal	50%
Nuclear	36%
Hydro/geothermal	2%
Oil/gas	3%
Other[b]	8%
Total Annual Production	272,155,000 MWh
Total Annual Load	284,556,000 MWh
Energy Imported Annually[c]	13,846,000 MWh
Generating Capacity	61,932 MWe
Peak Demand	55,477 MWe
Capacity Margin[d]	10,443 MWe

[a] Percentages do not total 100 percent due to rounding.
[b] Includes power from nonutility sources only.
[c] Energy imported is not the difference of production and load due to negative net pumped storage.
[d] Capacity margin is the amount of generating capacity available to provide for scheduled maintenance, emergency outages, system operating requirements, and unforeseen electrical demand.
Source: NERC 1993a.

3.7.3 AIR QUALITY AND NOISE

Meteorology and Climatology. The SRS region has a temperate climate with short, mild winters and long, humid summers. Throughout the year, the climate is frequently affected by warm and moist maritime air masses. The average annual temperature at SRS is 17.3 °C (63.2 °F); temperatures vary from an average daily minimum of 0.0 °C (32 °F) in January to an average daily maximum of 33.2 °C (91.7 °F) in July. The average annual precipitation at SRS is 113.4 cm (44.66 in). Precipitation is distributed fairly evenly throughout the year, with the highest precipitation in summer and the lowest in autumn. There is no predominant wind direction at SRS. The average annual windspeed at Augusta NWS Station is 2.9 m/s (6.5 mph) (NOAA 1994c:3). Additional information related to meteorology and climatology at SRS is presented in Appendix F.

Ambient Air Quality. The SRS is located near the center of the Augusta-Aiken Interstate AQCR #53. As of 1995, the areas within SRS and its surrounding counties were in attainment with respect to the NAAQS for criteria pollutants (40 CFR 50; 40 CFR 81.311; 40 CFR 81.341). Applicable NAAQS and the ambient air quality standards for South Carolina and Georgia are presented in Appendix F.

Since the creation of the PSD program in 1977, PSD permits have not been required for any new SRS emission sources, nor have modifications been required to existing permits. There are no known PSD Class I areas within 100 km (62 mi) of SRS.

The emissions inventory for sources at SRS for criteria pollutants are presented in Appendix F. Historically, the primary emission sources of criteria air pollutants at SRS have been the nine coal-burning and four fuel oil-burning boilers that produce steam and electricity (A-, D-, H-, K-, and P-Areas), the fuel and target fabrication facilities (M-Area), and processing facilities (F- and H-Areas). Other emissions and sources include fugitive particulates from coal piles and coal-processing facilities, vehicles, and temporary emissions from various construction-related activities.

Hazardous and toxic air pollutant standards have been adopted by the South Carolina Department of Health and Environmental Control. (No ambient standards for hazardous and toxic air pollutants have been proposed or established by the State of Georgia.) The annual emission rates of hazardous and toxic air pollutants from existing SRS facilities during 1990 are listed in Appendix F.

Table 3.7.3–1 presents the baseline ambient air concentration for criteria pollutants and other pollutants of concern at SRS. As shown in the table, baseline concentrations are in compliance with applicable guidelines and regulations.

Noise. Major noise sources at SRS are primarily located in developed or active areas and include various industrial facilities, equipment, and machines (for example, cooling systems, transformers, engines, pumps, boilers, steam vents, paging systems, construction and materials-handling equipment, and vehicles). Major noise emission sources outside of these active areas consist primarily of vehicles and rail operations. Existing SRS-related noise sources of importance to the public are those related to transportation of people and materials to and from the site, including trucks, private vehicles, helicopters, and trains.

Traffic from SRS operations is an important contributor to noise levels along site access highways through the nearby towns of New Ellenton, Jackson, and Aiken. Noise measurements recorded during 1989 and 1990 along State Route 125 in the town of Jackson at a point about 15 m (50 ft) from the roadway indicate that the 1-hour equivalent sound level from traffic ranged from 48 to 72 dBA. The estimated DNL average along this route was 66 dBA for summer and 69 dBA for winter. Similarly, noise measurements along State Route 19 in the town of New Ellenton at a point about 15 m (50 ft) from the roadway indicate that the 1-hour equivalent sound level from traffic ranged from 53 to 71 dBA. The estimated average DNL along this route was 68 dBA for summer and 67 dBA for winter (SR NUS 1990a:Appendices C and D).

Table 3.7.3–1. Comparison of Baseline Ambient Air Concentrations With Most Stringent Applicable Regulations or Guidelines at Savannah River Site, 1990

Pollutant	Averaging Time	Most Stringent Regulation or Guideline[a] (μg/m³)	Baseline Concentration (μg/m³)
Criteria Pollutants			
Carbon monoxide	8-hour	10,000[b]	22
	1-hour	40,000[b]	171
Lead	Calendar Quarter	1.5[b]	0.0004
Nitrogen dioxide	Annual	100[b]	5.7
Ozone	1-hour	235[b]	[c]
Particulate matter less than or equal to 10 microns in diameter	Annual	50[b]	3.0
	24-hour	150[b]	50.6
Sulfur dioxide	Annual	80[b]	14.5
	24-hour	365[b]	196
	3-hour	1,300[b]	823
Mandated by the State of South Carolina			
Total suspended particulates	Annual	75[d]	12.6
Gaseous fluorides	30-day	0.8[d]	0.09
	7-day	1.6[d]	0.39
	24-hour	2.9[d]	1.04
	12-hour	3.7[d]	1.99
Hazardous and Other Toxic Compounds			
3,3-Dichlorobenzidine	24-hour	0.15[d]	0.002
Acrolein	24-hour	1.25[d]	0.016
Benzene	24-hour	150.00[d]	31.711
Bis (chloromethyl) ether	24-hour	0.03[d]	0.002
Cadmium oxide	24-hour	0.25[d]	0.021
Chlorine	24-hour	75.00[d]	7.630
Chloroform	24-hour	250.00[d]	4.957
Cobalt	24-hour	0.25[d]	0.206
Formic acid	24-hour	225.00[d]	2.420
Manganese	24-hour	25.00[d]	0.821
Mercury	24-hour	0.25[d]	0.014
Nickel	24-hour	0.50[d]	0.271
Nitric acid	24-hour	125.00[d]	50.960
Parathion	24-hour	0.50[d]	0.007
Phosphoric acid	24-hour	25.00[d]	0.462

[a] The more stringent of the Federal and State standard is presented if both exist for the averaging time.
[b] Federal and State standard.
[c] Data not available from source document.
[d] State standard.

Note: Ozone, as a criteria pollutant, is not directly emitted or monitored by the site. See Section 4.1.3 for a discussion of ozone-related issues.

Source: 40 CFR 50; SC DHEC 1991a; SC DHEC 1992b; SR DOE 1995b.

Most industrial facilities at SRS are at a sufficient distance from the site boundary that noise levels at the boundary from these sources would not be measurable or would be barely distinguishable from background noise levels.

The States of Georgia and South Carolina, and the counties in which SRS is located, have not established any noise regulations that specify acceptable community noise levels, with the exception of a provision in the Aiken County Zoning and Development Standards Ordinance which limits daytime and nighttime noise by frequency band (Appendix F).

3.7.4 WATER RESOURCES

Surface Water. The most prominent hydrologic feature at SRS is the Savannah River, bordering the site for 32 km (19.9 mi) to the southwest. Six major streams flow through SRS to the Savannah River: Upper Three Runs Creek, Beaver Dam Creek, Fourmile Branch, Pen Branch, Steel Creek, and Lower Three Runs Creek. Upper Three Runs has two tributaries, Tims Branch and Tinker Creek; Pen Branch has one tributary, Indian Grave Branch; and Steel Creek has one tributary, Meyers Branch. These surface water features are shown in Figure 3.7.4–1.

The SRS withdraws surface water from the Savannah River mainly for industrial cooling water purposes. A small quantity is also removed for drinking water supplies. Total water withdrawn from the Savannah River is currently 140,438 million l/yr (37,100 million gal/yr). Most of the water withdrawn is returned to the Savannah River through its onsite tributaries. Streams, especially Fourmile Branch, that received discharges from reactors in the past are still recovering from scouring or erosion impacts. The average flow rate of the Savannah River is 283 m^3/s (9,990 ft^3/s). The lowest recorded flow rate, 183 m^3/s (6,500 ft^3/s), occurred during a drought period from 1985 to 1988 (SR DOE 1990a:3-18). The minimum flow of Fourmile Branch is 0.16 m^3/s (5.8 ft^3/s).

The Savannah River also supplies potable water to several municipalities (SR DOE 1995e:3-8). Upstream from SRS, the Savannah River supplies domestic and industrial water needs to Augusta, Georgia; and North Augusta, South Carolina. The river also receives sewage treatment plant effluent from Augusta, Georgia; North Augusta, Aiken, and Horse Creek Valley, South Carolina; and, as described above, from a variety of SRS operations via onsite stream discharges. Approximately 203 km (126 mi) downstream from SRS, the river supplies domestic and industrial water needs for the Cherokee Hill Water Treatment Plant at Port Wentworth, Georgia, and for Beaufort and Jasper Counties in South Carolina.

There are two manmade water bodies on SRS: L-Lake, which discharges to Steel Creek; and Par Pond, which empties into Lower Three Runs Creek. Naturally-occurring surface water bodies include approximately 190 Carolina bays scattered throughout the site. Carolina bays are closed depressions that may hold water. There are no direct discharges to the bays, but some do receive stormwater runoff.

Average annual treated sanitary discharge volume from SRS to the Savannah River is approximately 700 million l/yr (185 million gal/yr), which is approximately 50 percent of the new centralized sanitary wastewater treatment facility capacity. Wastewater from the treatment plant is discharged to Fourmile Branch.

The proposed facilities are to be located outside of the 100-year floodplain. Sitewide information concerning 500-year floodplains at SRS is not available, but site-specific 500-year floodplain assessments would be completed prior to modifications and/or construction of individual project proposals.

Surface Water Quality. In the vicinity of SRS, the Savannah River and onsite streams are classified as fresh water suitable for the following: primary and secondary contact recreation; a source of drinking water, after conventional treatment in accordance with the requirements of the South Carolina Department of Health and Environmental Control; fishing and the survival and propagation of a balanced indigenous aquatic community of fauna and flora; and industrial and agricultural uses (SC DHEC 1992a:29). Table 3.7.4–1 lists the surface water monitoring results for 1993 for the Savannah River downstream of SRS. The only parameters that exceeded Federal or State water quality criteria were aluminum, manganese, and turbidity.

In addition to water quality monitoring, SRS conducts monitoring to ensure compliance with NPDES permit limits. SRS has two NPDES permits for industrial wastewater discharge that cover 81 outfalls as part of the permit requirements and 1 general stormwater discharge permit that covers 48 outfalls. SRS collects and analyzes water from these outfalls to ensure compliance with NPDES permit limits. Of the 8,000 analyses performed at the industrial outfalls in 1993, 10 exceeded permit limits, for a compliance rate of 99.9 percent. Noncompliances were noted mainly for pH and total suspended solids with one noncompliance each for oil and

Table 3.7.4–1. Summary of Surface Water Quality Monitoring at Savannah River Site, 1993

Parameter	Unit of Measure	Water Quality Criteria and Standards[a]	Water Body Concentration	
			High	Low
Alkalinity	mg/l	NA	24	13
Alpha (gross)	pCi/l	15[b]	0.51	-0.2
Aluminum	mg/l	0.05 to 0.2[c]	0.838	0.182
Ammonia (nitrogen)	mg/l	NA	0.11	0.02
Beta (gross)	pCi/l	50[d]	3.41	0.9
Calcium	mg/l	NA	5.09	3.25
Chemical oxygen demand	mg/l	NA	<dL	<dL
Chromium	mg/l	0.1[b,e]	<dL	<dL
[Text deleted.]				
Dissolved oxygen	mg/l	>5.0[e]	10.5	6.2
Iron	mg/l	0.3[c]	1.15	0.516
Lead	mg/l	0.015[b]	0.003	<dL
Magnesium	mg/l	NA	1.34	1.11
Manganese	mg/l	0.05[c]	0.064	0.04
Nitrogen (as NO_2/NO_3)	mg/l	NA	0.31	0.18
pH	pH units	6.5 to 8.5[c]	6.8	6.0
Phosphate	mg/l	NA	<dL	<dL
Plutonium-238	pCi/l	1.6[f]	0.001	-0.001
Plutonium-239	pCi/l	1.2[f]	0.001	0.0009
Sodium	mg/l	NA	12.7	5.28
Strontium-90	pCi/l	400[f]	0.24	0.0017
Sulfate	mg/l	250[c]	9	4
Suspended solids	mg/l	NA	16	5
Temperature	°C	<32.2[e]	25.7	9.1
Total dissolved solids	mg/l	500[c]	90	49
Tritium	pCi/l	80,000[f]	5,690	-147
Turbidity	turbidity unit	1 to 5[e]	28	3.6
Zinc	mg/l	5.0[c]	0.012	<dL

[a] For comparison purposes only.

[b] National Primary Drinking Water Regulations (40 CFR 141).

[c] National Secondary Drinking Water Regulations (40 CFR 143).

[d] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).

[e] South Carolina State water quality criteria.

[f] DOE's DCG for water (DOE Order 5400.5). DCG values are based on a committed effective dose equivalent of 100 mrem/yr; however, because the drinking water maximum contaminant level is based on 4 mrem/yr, the number listed is 4 percent of the DCG. All concentrations of radionuclides are determined by subtracting the instrument background environmental level from the monitored location. A negative or zero incremental concentration means that the concentration at the sampling location is equivalent to the background environmental level.

Note: All nonradiological data from station R-10, downstream of SRS; all radiological data from station R-3B (below Vogtle); NA=not applicable; dL=detection limit.

Source: WSRC 1994d; WSRC 1994f.

grease and biological oxygen demand (WSRC 1994d:116). In all cases, either corrective actions or an administrative review were taken to prevent future noncompliances.

Surface Water Rights and Permits. Surface water rights for the Savannah River are determined by the Doctrine of Riparian Rights. Under this doctrine, users of water must not adversely effect the quantity or quality of water available for downstream users.

Groundwater. Several aquifer system naming schemes have been used at SRS. For this document, the most shallow aquifer will be referred to as the water table aquifer. This aquifer is supported by the leaky "Green Clay" aquitard, which confines the Congaree Aquifer. Below the Congaree Aquifer is the leaky Ellenton aquitard, which contains the Cretaceous (also known as the Tuscaloosa) aquifer. In general at SRS, groundwater in the water table aquifer flows downward to the Congaree Aquifer or discharges to nearby streams that intersect the water table. Flow in the Congaree Aquifer is downward to the Cretaceous Aquifer or horizontal to Upper Three Runs Creek or the Savannah River, depending on the location at SRS. Groundwater in the Cretaceous Aquifer discharges predominantly along the Savannah River. However, Upper Three Runs Creek also receives groundwater from the Cretaceous Aquifer. This flow creates an upward gradient between the Cretaceous and Congaree Aquifer over a significant portion of SRS (Figure 3.7.4–1).

The Cretaceous Aquifer is an abundant and important water resource for the SRS region. Some of the local cities (Aiken, for example) also obtain groundwater from the Cretaceous, but most of the rural population in the SRS region draws water from either the Congaree or water table aquifer. All groundwater at SRS is classified by the EPA as a Class II water source (current and potential source of drinking water). Depth to groundwater ranges from at or very near the ground surface (near streams) to approximately 46 m (151 ft). In 1993, SRS withdrew 13,247 million l/yr (3,500 million gal/yr) of groundwater in support of site operations.

Groundwater Quality. Groundwater quality data have been obtained from SRS monitoring wells for the past several years. Groundwater quality at SRS ranges from excellent (soft and slightly acidic) to below EPA drinking water standards for several constituents in the vicinity of some waste sites. The Cretaceous Aquifer is generally unaffected except for a small portion of the A-Area where trichloroethylene has been detected. The Congaree Aquifer is contaminated with trichloroethylene in much of the A- and M-Areas, with trichloroethylene and also some low levels of tritium in the General Separations Area. The water table aquifer is contaminated with solvents, metals, and low levels of radionuclides at several waste sites and facilities at SRS (Figure 3.7.4–1). All contaminated groundwater at SRS discharges to streams on the SRS or the Savannah River. Groundwater quality monitoring data is presented in Table 3.7.4–2.

Groundwater Availability, Use, and Rights. Groundwater is a domestic, municipal, and industrial water source throughout the Upper Coastal Plain. Most municipal and industrial water supplies in Aiken County are from the Cretaceous Aquifer. Domestic water supplies are primarily from the Congaree Aquifer and the water table. In Barnwell and Allendale Counties, the Congaree Aquifer supplies some municipal users. Groundwater production from these wells is approximately 13,247 million l/yr (3,500 million gal/yr), which is similar to the volume pumped for industrial and municipal production within 16 km (9.9 mi) of the site.

Groundwater rights in South Carolina are traditionally associated with absolute ownership rule. Originating in English common law doctrine, the owners of land overlying a groundwater resource are allowed to withdraw from their wells all the water they desire (VDL 1990a:725); however, the *Water Use Reporting and Coordination Act* requires all users of 379,000 l/day (100,000 gal/day) or more per day (138.3 million l/yr [36.5 million gal/yr]) of water to report their withdrawal rates to the South Carolina Water Resources Commission. SRS groundwater use exceeds this amount, and, consequently, its withdrawal rates are reported to the commission.

Table 3.7.4–2. Groundwater Quality Monitoring at Savannah River Site, 1993

Parameter	Unit of Measure	Water Quality Criteria and Standards[a]	Existing Conditions	
			High	Low
Alpha (gross)	pCi/l	15[b]	77.61	0.96
Barium	mg/l	2.0[b]	0.09	0.0017
Beta (gross)	pCi/l	50[c]	75.88	1.00
Chloride	mg/l	250[d]	14.69	1.3
Iron	mg/l	0.3[d]	75.0	0.004
Lead	mg/l	0.015[b]	0.05	0.0015
Manganese	mg/l	0.05[d]	0.038	0.0018
Nitrate	mg/l	10[b]	2.37	0.03
pH	pH units	6.5-8.5[d]	11.6	4.7
[Text deleted.]				
Sulfate	mg/l	250[d]	118.1	0.5
Total dissolved solids	mg/l	500[d]	1,879.4	5.8
Total organic halogens	mg/l	NA	0.84	0.0025
Total phosphates	mg/l	NA	4.7	0.023
Total radium	pCi/l	5.0[c]	0.52	0.00628
Tritium	pCi/l	80,000[e]	1,162,810	350

[a] For comparison only.

[b] National Primary Drinking Water Regulations (40 CFR 141).

[c] Proposed National Primary Drinking Water Regulations; Radionuclides (56 FR 33050).

[d] National Secondary Drinking Water Regulations (40 CFR 143).

[e] DOE's DCG for water (DOE Order 5400.5). DCG values are based on a committed effective dose equivalent of 100 mrem per year; however, because the drinking water maximum contaminant level is based on 4 mrem per year, the number listed is 4 percent of the DCG.

Note: NA=not applicable.

Source: SRS 1995a:6.

3.7.5 Geology and Soils

Geology. The SRS is located in the Aiken Plateau portion of the Upper Atlantic Coastal Plain approximately 32 km (20 mi) east of the Fall Line, a major physiographic and structural feature that separates the Piedmont and Coastal Plain physiographic provinces, in southeastern South Carolina. The plateau is highly dissected, with narrow, steep-sided valleys separated by broad, flat areas.

Coastal Plain sediments underlying SRS consist of sandy clays and clayey sands, although occasional beds of clean sand, gravel, clay, or carbonate occur. The Coastal Plain sediments overlie a basement complex composed of Paleozoic crystalline and Triassic sedimentary formations of the Dunbarton Basin.

Small and discontinious thin calcareous sand zones, potentially subject to dissolution by water, have been located in some parts of SRS. If dissolution occurs in these zones, potential underground subsidence resulting in settling of the ground surface could occur. No settling as a result of dissolution of these zones has been identified. No economically viable geologic resources have been identified at SRS.

In the immediate region of SRS, there are no known capable faults as defined by 10 CFR 100, Appendix A. Several faults have been identified from subsurface mapping and seismic surveys within the Paleozoic and Triassic basement beneath SRS. The largest of these is the Pen Branch fault. However, there is no evidence of movement within the last 38 million years along this fault (DOE 1991c:4-108).

The SRS is located within Seismic Zone 2, indicating moderate damage could occur as a result of earthquakes (Figure 3.2.5–1). Since 1985, three earthquakes, all of Richter magnitude 3.2 or less, have occurred in the immediate area of SRS (Table 3.2.5–1). None of these earthquakes produced any damage at SRS. Historically, two large earthquakes have occurred within 300 km (186 mi) of SRS. The largest of these, the Charleston earthquake of 1886, had an estimated Richter magnitude ranging from 6.5 to 7.5. Earthquakes capable of producing structural damage to buildings are not likely to occur in the vicinity of SRS (SR DOE 1995e:3-4). There is no volcanic hazard at SRS; the area has not experienced volcanic activity within the last 230 million years.

Soils. The soils at SRS are primarily sands and sandy loams. The somewhat excessively drained soils have a thick, sandy surface layer that extends to a depth of 2 m (6.6 ft) or more in some areas (SR USDA 1990a:17-25). Many of the soils are subject to erosion, flooding, ponding, and cutbank caving. The soils at SRS are considered acceptable for standard construction techniques.

3.7.6 BIOLOGICAL RESOURCES

Terrestrial Resources. Most of SRS has remained undeveloped since it was established in 1950. Only about 5 percent of the site is occupied by DOE facilities. Five major plant communities have been identified at SRS (Figure 3.7.6–1). Of these, the largest is the loblolly, longleaf, slash pine community, which covers approximately 65 percent of the site. This community type, as well as upland hardwood-scrub oak, occurs primarily in upland areas. Swamp forests and bottomland hardwood forests are found along the Savannah River and the numerous streams that traverse SRS. More than 1,300 species and variations of vascular plants have been identified on the site (DOE 1992e:4-126,4-128).

Because of the variety of plant communities on the site, as well as the region's mild climate, SRS supports a diversity and abundance of wildlife, including 43 amphibian, 58 reptile, 213 bird, and 54 mammal species. Common species at SRS include the slimy salamander, eastern box turtle, Carolina chickadee, common crow, eastern cottontail, and gray fox (DOE 1992e:4-128; WSRC 1993b:3-5,3-39). A number of game animals are found on SRS, but only the whitetail deer and feral hog are hunted onsite (DOE 1992e:4-128). Raptors, such as the Cooper's hawk and black vulture, and carnivores, such as the gray fox and raccoon, are ecologically important groups on SRS. A variety of migratory birds have been found at SRS. Migratory birds, as well as their nests and eggs, are protected by the *Migratory Bird Treaty Act*. Eagles are similarly protected by the *Bald and Golden Eagle Protection Act*.

Four of the five major plant communities at SRS are found on the proposed collocated storage site (Figure 3.7.6–1). The most common of these plant communities is the loblolly-longleaf-slash pine, followed by upland hardwood-scrub oak, pine/hardwood, and bottomland hardwood. Although not shown on Figure 3.7.6–1, cleared fields are also common on the proposed site. A 5.5 ha (13.6 acres) NERP oak-hickory forest set-aside area, which has an unusual composition of flora, is located near the northwest corner of the proposed site (SR DOE 1991b:4.3,4.26). Although specific studies of plant and animal communities found on the proposed collocated storage site have not been conducted, the occurrence of species on the site is expected to be the same as found in similar habitats elsewhere on SRS.

Ecological studies of the assumed analysis site for the MOX fuel fabrication facility have not been conducted, but the site is located within an area that primarily contains the loblolly, longleaf, and slash pine forest type (Figure 3.7.6–1). Some bottomland hardwood forest is located along the drainages that feed Par Pond. Wildlife species found in the area of the assumed site would be expected to be similar to those found in similar habitat throughout SRS.

The assumed analysis site for the evolutionary LWR is located in an area that is classified as loblolly, longleaf, and slash pine forest (Figure 3.7.6–1). Previous studies of the site area determined that pine plantations were the predominant plant cover. Other vegetation types present include old-field, bottomland hardwood forest, mixed forest, upland deciduous forest, grassland (under powerline rights-of-way), and emergent wetland. The assumed site has not been surveyed to determine the presence and abundance of wildlife (DOE 1992e:4-128). Animals present would be expected to be similar to those found in similar habitat throughout SRS.

Wetlands. The SRS contains approximately 19,800 ha (49,000 acres) of wetlands, most of which are associated with floodplains, streams, and impoundments (DOE 1992e:4-128). Wetlands on the site may be divided into the following categories: bottomland hardwoods, cypress-tupelo, scrub-shrub, emergent, and open water (WSRC 1993b:4-6). The most extensive wetland type on SRS is swamp forest associated with the Savannah River floodplain. Approximately 3,800 ha (9,390 acres) of these wetlands are found on SRS. Past releases of cooling water effluent into site streams and the Savannah River Swamp have resulted in shifts in plant community composition. Changes have included the replacement of bald cypress by scrub-shrub and emergent vegetation in the swamp and reduction in bottomland forests along streams (DOE 1992e:4-128; WSRC 1989e:3-4).

Carolina bays, a type of wetland unique to the southeastern United States, are also found on SRS. Approximately 190 Carolina bays have been identified on the site. These natural shallow depressions occur on interstream areas of SRS and range from lakes to shallow marshes, herbaceous bogs, shrub bogs, or swamp forests (SR NERP 1989a:9).

Wetlands found on the proposed collocated storage site include bottomland hardwoods and three Carolina bays. Bottomland hardwood areas occur along tributaries to Upper Three Runs Creek. The three Carolina bays on the proposed site are typical of the smaller bays found on the SRS (SR DOE 1991b:4.3). All show evidence of previous draining and agricultural use. The larger of the bays is about 1 ha (2.5 acres) in size and is surrounded by oaks and sweet gum. Jurisdictional wetlands subject to COE regulation have not been delineated on this site using the U.S. Army COE *Wetlands Delineation Manual* (Y-87-1).

Wetlands found within the assumed analysis site for the MOX fuel fabrication facility include bottomland hardwoods associated with drainages that feed Par Pond. There are no Carolina bays located on the site. Par Pond, located to the east of the assumed site, supports a well-developed wetland community along its shores. The suitability of habitat in Par Pond for wetland vegetation is indicated by the extensive development of wetland vegetation on the lake and the spread of wetland vegetation from its shore into the lake (DOE 1992e:4-130).

The assumed analysis site for the evolutionary LWR contains a number of wetland areas. Several wetlands are associated with intermittent tributaries to Pen Branch and Fourmile Branch. Isolated wetlands are also found in the site area. Rainbow Bay, a 2.4-ha (5.9-acre) Carolina bay, occurs in the northeastern portion of the assumed site. Other isolated wetlands in the site area are upland depressions. Unlike Rainbow Bay, these wetlands do not have standing water for long periods of time (DOE 1992e:4-129).

Aquatic Resources. Aquatic habitat on SRS includes manmade ponds, Carolina bays, reservoirs, and the Savannah River and its tributaries. There are more than 50 manmade impoundments located throughout the site that support populations of bass and sunfish (SR DOE 1982a:4-22; SRS 1992a:8). Fewer than 20 Carolina bays have permanent fish populations. Species present in these bays include redfin pickerel, mud sunfish, lake chubsucker, and mosquitofish (SR NERP 1983a:40–42; SR NERP 1989a:37). Par Pond and L-Lake support similar fish populations including largemouth bass, black crappie, and various species of pan fish (DOE 1992e:4-131; SRS 1992a:8). Sport and commercial fishing is not allowed on the SRS site (DOE 1992e:4-132).

The Savannah River is used for both commercial and sport fishing. Important commercial species are American shad, hickory shad, and striped bass, all of which are anadromous. The most important warm-water game fish found in the Savannah River are bass, pickerel, crappie, bream, and catfish (SR DOE 1982a:4-28). In the past, water intake structures for C- and K-Reactors and the D-Area powerhouse caused annual estimated entrainment of approximately 10 percent of the fish eggs and larvae passing the intake canals during the spawning season. In addition, estimated impingement losses were approximately 7,600 fish per year (SR DOE 1987b:3-31,C-61).

Aquatic habitat in the vicinity of the proposed storage facility site consists of Upper Three Runs Creek and its tributaries and three Carolina bays (see Figure 3.7.4–1). Streams in the vicinity of the proposed site support largemouth bass, black crappie, and various species of pan fish. Upper Three Runs Creek has never received thermal effluents, but has received industrial pollutants from Tim's Branch. The creek has a rich fauna and is minimally affected by pollutants (SR NERP 1983a:11,13). Upper Three Runs Creek may also be an important spawning area for the blueback herring, and may be seasonally important as a nursery habitat for a number of important Savannah River species, including American shad, blueback herring, and striped bass (SR DOE 1982a:4-28). Information concerning aquatic resources in the three Carolina bays on the proposed site is unavailable (SR DOE 1991b:4.3).

Aquatic resources in the vicinity of the assumed analysis site for the MOX fuel fabrication facility area include Par Pond, precooling ponds 2 and 5, as well as the canal that connects these three water bodies. Also present are a number of drainages that feed Par Pond. Par Pond drains into Lower Three Runs Creek. A total of 30 species of fish, including chubsucker, largemouth bass, bluegill, and black crappie, have been recorded in Par Pond (DOE 1992e:4-131). The same species have been recorded in Lower Three Runs Creek (WSRC 1993b:15-64). During operation of P-Reactor, heated effluent was discharged into an arm of Par Pond (Pond C) via the above-mentioned canal and precooling ponds. Since the shutdown of the P-Reactor, the precooling ponds and Pond C have undergone substantial recovery (DOE 1992e:4-131).

The principal aquatic resources in the vicinity of the assumed analysis site for the evolutionary LWR include Fourmile Branch, Par Branch, and Rainbow Bay. Rainbow Bay does not contain standing water year-round. In the past, Fourmile Branch and Pen Branch have received thermal effluents from C- and K-Reactors, respectively. During reactor operations, fish populations in warmed portions of the streams were greatly reduced, with the mosquitofish being the most abundant species. With the cessation of reactor operation, a more diverse fish population has recolonized both streams (WSRC 1993b:12-44,13-42). Above the reactor outfalls, both Fourmile Branch and Pen Branch are small streams that have been relatively unaffected by past SRS operation. The dominant fish in the un-heated upper reaches of Pen Branch include sunfish, bullheads, and chubsuckers (SR DOE 1987b:3-51); species composition of the upper portion of Fourmile Branch would be expected to be similar.

Threatened and Endangered Species. Sixty-one federally and State-listed threatened, endangered, and other special status species may be found on and in the vicinity of SRS (Table 3.7.6–1). Fifty-seven of these species have records of occurrence on SRS, twelve of which are federally or State-listed as threatened or endangered. Once specific project locations have been determined, site surveys will verify the presence of special status species. No critical habitat for threatened or endangered species, as defined in ESA (50 CFR 17.11; 50 CFR 17.12), exists on SRS.

The smooth coneflower is the only endangered plant species found on SRS. Two colonies exist on SRS, but suitable habitat for this species occurs throughout the site. Bald eagles nest near Par Pond and L-Lake and forage on these reservoirs. Wood storks forage in the Savannah River Swamp and the lower reaches of Steel Creek, Pen Branch, Beaver Dam Creek, and Fourmile Branch. Red-cockaded woodpeckers inhabit open pine forests with mature trees (older than 70 years for nesting and 30 years for foraging). Peregrine falcons have been reported in the past as rare winter visitors on SRS. The American alligator is a common inhabitant of Par Pond, Beaver Dam Creek, and the Savannah River Swamp. The shortnose sturgeon spawns in the Savannah River both up and downstream of SRS. This fish has not been collected in the tributaries of the Savannah River that drain SRS, but sturgeon ichthyoplankton have been collected in the river near SRS (SR DOE 1995b:3-44). The Kirtland's warbler is a migrant species which historically occurred on SRS. The State-listed Rafinesque's big-eared bat, common ground dove, and Appalachian Bewick's wren have also been observed on SRS.

There are no federally listed threatened and endangered species known to occur on the proposed storage facility site, but several may exist in the general vicinity. Active bald eagle nests are located about 13.7 km (8.5 mi) southwest of the proposed site in an area of Pen Branch and approximately 12.1 km (7.5 mi) southeast of the site just south of Par Pond. Wood storks have been observed near the Fourmile Branch delta (WSRC 1993b:21-42,21-43) about 21 km (13 mi) from the proposed site. Although suitable forage habitat for the red-cockaded woodpecker exists on the proposed storage facility site, the closest colony is located approximately 4.8 km (3 mi) away. Occurrences of the American alligator are all located about 6.4 km (4 mi) or more from the site (WSRC 1993b:21-11,21-32,21-41,21-42,21-43). The shortnose sturgeon spawns in the Savannah River upstream of SRS, and larvae of this species have been collected in or near the water intake canals on the river. However, entrainment or impingement of this species at SRS water intake structures has not been documented (DOE 1992e:4-132). The smooth coneflower has not been recorded in affected areas but could be found on the proposed site. Several State special status species have also been found in the proposed storage site area.

Table 3.7.6–1. Federally and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found on or in the Vicinity of Savannah River Site

Common Name	Scientific Name	Status[a]	
		Federal	State
Mammals			
Meadow vole	*Microtus pennsylvanicus*	NL	SC
Rafinesque's big-eared bat[b]	*Plecotus rafinesquii*	NL	SE
Southern Appalachian eastern woodrat[b]	*Neotoma floridana haematoreia*	NL	SC
Spotted skunk[b]	*Spilogale putorius*	NL	SC
Star-nosed mole[b]	*Condylura cristata parva*	NL	SC
Swamp rabbit	*Sylvilagus aquaticus*	NL	SC
Birds			
American peregrine falcon[b,c]	*Falco peregrinus anatum*	E	SE
American swallow-tailed kite	*Elanoides forficatus*	NL	SE
Appalachian Bewick's wren[b]	*Thryomanes bewickii altus*	NL	ST
Arctic peregrine falcon[b]	*Falco peregrinus tundrius*	E (S/A)	ST
Bald eagle[b,c]	*Haliaeetus leucocephalus*	T	SE
Barn owl[b]	*Tyto alba*	NL	SC
Common ground dove[b]	*Columbina passerina*	NL	ST
Cooper's hawk[b]	*Accipiter cooperii*	NL	SC
Kirtland's warbler[b]	*Dendroica kirtlandii*	E	SE
[Text deleted.]			
Mississippi kite[b]	*Ictinia mississippiensis*	NL	SC
Red-cockaded woodpecker[b,c]	*Picoides borealis*	E	SE
Red-headed woodpecker[b]	*Melanerpes erythrocephalus*	NL	SC
Swainson's warbler[b]	*Limnothlypis swainsonii*	NL	SC
Wood stork[b,d]	*Mycteria americana*	E	SE
Reptiles			
American alligator[b]	*Alligator mississippiensis*	T (S/A)	NL
Carolina swamp snake[b]	*Seminatrix pygaea*	NL	SC
Eastern coral snake[b]	*Micrurus fulvius fulvius*	NL	SC
Green water snake[b]	*Nerodia cyclopion*	NL	SC
[Text deleted.]			
Spotted turtle[b]	*Clemmys guttata*	NL	SC
Amphibians			
Carolina crawfish frog[b]	*Rana areolata capito*	NL	SC
Eastern bird-voiced treefrog[b]	*Hyla avivoca ogechiensis*	NL	SC
Eastern tiger salamander[b,d]	*Ambystoma tigrinum tigrinum*	NL	SC
Northern cricket frog[b]	*Acris crepitans crepitans*	NL	SC
Pickerel frog[b,d]	*Rana palustris*	NL	SC
Upland chorus frog[b]	*Pseudacris triseriata feriarum*	NL	SC

Table 3.7.6–1. Federally and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found on or in the Vicinity of Savannah River Site—Continued

Common Name	Scientific Name	Status[a] Federal	Status[a] State
Fish			
[Text deleted.]			
Shortnose sturgeon[b,c,d]	*Acipenser brevirostrum*	E	SE
Invertebrates			
Brother spike mussel	*Elliptio fraterna*	NL	E
Plants			
[Text deleted.]			
Beak-rush[b,d]	*Rhynchospora inundata*	NL	SC
Beak-rush[b,d]	*Rhynchospora tracyi*	NL	SC
Bog spice bush[b]	*Lindera subcoriacea*	NL	RC
[Text deleted.]			
Cypress stump sedge[b,d]	*Carex decomposita*	NL	SC
Durand's white oak[b]	*Quercus durandii*	NL	SC
Dwarf bladderwort[b]	*Utricularia olivacea*	NL	SC
Dwarf burhead[b]	*Echinodorus parvulus*	NL	SC
Elliott's croton[b]	*Croton elliottii*	NL	SC
Few-fruited sedge[b]	*Carex oligocarpa*	NL	SC
Florida bladderwort[b]	*Utricularia floridana*	NL	SC
Florida false loosestrife[b]	*Ludwigia spathulata*	NL	SC
Gaura[b]	*Gaura biennis*	NL	SC
Green-fringed orchid[b,d]	*Platanthera lacera*	NL	SC
Leafy pondweed[b]	*Potamogeton foliosus*	NL	SC
Loose water-milfoil[b]	*Myriophyllum laxum*	NL	RC
Milk-pea[b]	*Astragalus villosus*	NL	SC
Nailwort[b,d]	*Paronychia americana*	NL	SC
Nestronia[b]	*Nestronia umbellula*	NL	SC
Nutmeg hickory[b]	*Carya myristiciformis*	NL	RC
Oconee azalea[b]	*Rhododendron flammeum*	NL	SC
Pink tickseed[b]	*Coreopsis rosea*	NL	RC
Quill-leaved swamp potato[b]	*Sagittaria isoetiformis*	NL	SC
Sandhill lily[b]	*Nolina georgiana*	NL	SC
Smooth coneflower[b]	*Echinacea laevigata*	E	SE
Trepocarpus[b]	*Trepocarpus aethusae*	NL	SC
Wild water-celery[b]	*Vallisneria americana*	NL	SC
Yellow cress[b]	*Rorippa sessiliflora*	NL	SC
Yellow wild indigo[b]	*Baptisia lanceolata*	NL	SC

[a] Status codes: E=endangered; NL=not listed; RC=regional of concern (unofficial plants only); S/A=protected under the similarity of appearance provision of the ESA; SC=State of concern; SE=State endangered (official state list-animals only); ST=State threatened (official State list-animals only); and T=threatened.

[b] Species occurrence recorded on SRS.

[c] USFWS Recovery Plan exists for this species.

[d] Species known to occur on Upper Three Runs Creek downstream from the proposed site for the new consolidated storage facility or in areas affected by the project.

Source: 50 CFR 17.11; 50 CFR 17.12; DOE 1992e; SC WD 1995a; SR NERP 1990b; WSRC 1993b.

A population of nailwort has been found within the central portion of the site and the green-fringed orchid has been collected in an area adjacent to the site (SR NERP 1990b:64-65).

Bald eagles have been seen on numerous occasions in the vicinity of Par Pond, and an eagle nest is located about 5.6 km (3.5 mi) southeast of the assumed analysis site for the MOX fuel fabrication facility. Although suitable forage habitat for the red-cockaded woodpecker exists in the site area, the nearest known red-cockaded colony is located about 8 km (5 mi) to the southeast. The American alligator is also a common inhabitant of Par Pond, located less than 1.6 km (1 mi) from the assumed site (WSRC 1993b:21-11,21-26,21-32).

There are no federally listed threatened and endangered species known to occur on the assumed analysis site for the evolutionary LWR, but several may exist in the general vicinity. Bald eagles have been observed at several locations on SRS, particularly in the vicinity of Par Pond and L-Lake. Active bald eagle nests are located 8 km (5 mi) southwest of the site in the area of Pen Branch and 11.3 km (7 mi) southeast of the site just south of Par Pond (WSRC 1993b:21-26). Although suitable forage habitat for the red-cockaded woodpecker exists on the assumed analysis site for the evolutionary LWR, the closest colony is located 11.3 km (7 mi) away. The American alligator is a common inhabitant of Par Pond, Beaver Dam Creek, and the Savannah River swamp, all located 8 km (5 mi) or more from the assumed site (WSRC 1993b:21-11,21-32,21-41,21-43). The federally listed smooth purple coneflower has not been recorded in the site but could be present. [Text deleted.] Several State special status species have also been found near Rainbow Bay, including the Cooper's hawk, two species of beak-rush, Florida false loosestrife, and green-fringed orchid.

3.7.7 CULTURAL AND PALEONTOLOGICAL RESOURCES

Prehistoric Resources. Prehistoric resources at SRS consist of villages, base camps, limited activity sites, quarries, and workshops. An extensive archaeological survey program began at SRS in 1974 and includes numerous field studies such as reconnaissance surveys, shovel test transects, and intensive site testing and excavation. More than 60 percent of SRS has received some level of cultural resources evaluation. More than 800 prehistoric sites have been identified, some of which may fall within the locations of the proposed storage facilities. Fewer than 8 percent of these sites have been evaluated for NRHP eligibility. To date 67 prehistoric and historic sites are considered potentially eligible for listing on the NRHP.

A Programmatic Agreement was signed by the DOE Savannah River Operations Office, the South Carolina SHPO, and the Advisory Council on Historic Preservation on August 24, 1990. Its purpose is to ensure that appropriate measures are taken to inventory, evaluate, protect, and enhance archaeological sites on SRS. In addition, an Archaeological Resource Management Plan for SRS is in place.

Historic Resources. Types of historic sites include farmsteads, tenant dwellings, mills, plantations and slave quarters, rice farming dikes, dams, cattle pens, ferry locations, towns, churches, schools, cemeteries, commercial building locations, and roads. Approximately 400 historic sites or sites with historic components have been identified within SRS, some of which may fall within the locations of the proposed storage facilities. To date, approximately 10 percent have been evaluated for NRHP eligibility.

Most historic structures were demolished during the initial establishment of SRS in 1950. Two 1951 buildings are currently in use. SRS has been involved in tritium operations and other nuclear material production for more than 40 years. Therefore, some of the facilities at SRS may be eligible for listing on the NRHP.

Native American Resources. Native American groups with traditional ties to the area include the Apalachee, Cherokee, Chickasaw, Creek, Shawnee, Westo, and Yuchi. At different times, each of these groups was encouraged by the English to settle in the area to provide protection from the French, Spanish, or other Native American groups. Main villages of both the Cherokee and Creek were located southwest and northwest of SRS, but both groups may have used the area for hunting and gathering activities. During the early 1800s, most of the remaining Native Americans residing in the region were relocated to the Oklahoma territory.

Native American resources in the region include remains of villages or townsites, ceremonial lodges, burials, cemeteries, and areas containing traditional plants used for religious ceremonies. Literature reviews and consultations with Native American representatives reveal that there are some concerns related to the *American Indian Religious Freedom Act* within the central Savannah River valley, including some sensitive Native American resources and several plants traditionally used in ceremonies (SR DOE 1991e:19,21).

Paleontological Resources. Paleontological materials at SRS include fossil plants, numerous invertebrate fossils, deposits of giant oysters (*Crassostrea gigantissima*), mollusks, and bryozoa. All paleontological materials from SRS are marine invertebrate deposits and, with the exception of the giant oysters, are relatively widespread common fossils; therefore the assemblages have low research potential.

3.7.8 SOCIOECONOMICS

Socioeconomic characteristics addressed at SRS include employment and regional economy, population and housing, community services, and local transportation. Statistics for employment and regional economy are presented for the REA that encompasses 15 counties around SRS located in Georgia and South Carolina (Table L.1–1). Statistics for population and housing, community services, and local transportation are presented for the ROI, a six-county area in which 90.1 percent of all SRS employees reside: Aiken County (51.9 percent), Allendale County (1.1 percent), Bamberg County (1.7 percent), and Barnwell County (7.3 percent) in South Carolina and Columbia County (10.6 percent) and Richmond County (17.5 percent) in Georgia (Table L.1–7). In 1993, SRS employed 23,351 persons which decreased to 16,562 persons in 1996.

Regional Economy Characteristics. Selected employment and regional economy statistics for the SRS REA are summarized in Figure 3.7.8–1. Between 1980 and 1990, the civilian labor force in the REA increased 21.4 percent to the 1990 level of 248,239. The 1994 unemployment in the REA was 6.7 percent, which was approximately 0.4 and 1.5 percent higher than the unemployment for South Carolina and Georgia, respectively. The region's per capita income of $17,212 in 1993 was approximately 2.1 percent greater than South Carolina's per capita income of $16,861 and 10.6 percent lower than Georgia's per capita income of $19,249.

In 1993, the percentage of total employment involving the private sector activity of retail trade in the REA (16 percent) was comparable to the statewide economies of South Carolina and Georgia, as shown in Figure 3.7.8–1. Service employment in the region (22 percent of total employment) represented a 3-percent smaller share of the total employment in the region than in Georgia but was similar to that of South Carolina. The manufacturing sector in the region (21 percent) represented a 1- and 6-percent greater share of the total employment than in South Carolina (20 percent) and Georgia (15 percent), respectively.

Population and Housing. In 1994, the ROI population totaled 457,812. From 1980 to 1994, the ROI population grew by 21.7 percent, compared to 29.1 percent in Georgia and 17.4 percent in South Carolina. Within the ROI, Columbia County experienced the largest increase, 99.2 percent, while Bamberg County's population decreased 7.8 percent. Population and housing trends are summarized in Figure 3.7.8–2.

The increase in number of housing units in the ROI between 1980 and 1990, 23.8 percent, was similar to the increase in South Carolina, but approximately 6 percent less than the increase in Georgia. The total number of housing units for 1990 was 168,803. The 1990 homeowner vacancy rate for the ROI, 2.2 percent, was comparable to the statewide rates for South Carolina and Georgia. The renter vacancy rate for the ROI counties, nearly 10 percent, was approximately 2 percent less than the renter vacancy rates for both States.

Community Services. Education, public safety, and health care characteristics were used to assess the level of community service in the SRS ROI. Figure 3.7.8–3 presents school district characteristics for the SRS ROI. Figure 3.7.8–4 presents public safety and health care characteristics.

Education. In 1994, nine school districts provided public education services and facilities in the SRS ROI. As shown in Figure 3.7.8–3, these school districts operated at between 58.7-percent (Allendale County) and 100-percent (Columbia County School District) capacity. The average student-to-teacher ratio for the SRS ROI in 1994 was 17.5:1. The Aiken County School District had the highest ratio at 19:1.

Public Safety. City, county, and State law enforcement agencies provided police protection to the residents in the ROI. In 1994, a total of 954 sworn police officers were serving the six-county ROI. Richmond County employed the greatest number of sworn police officers (325), while the city of Augusta, Georgia had the highest officer-to-population ratios (3.9 sworn officers per 1,000 persons). The average ROI officer-to-population ratio was 2.1 officers per 1,000 persons. Figure 3.7.8–4 compares police force strengths across the ROI.

Fire protection services in the SRS ROI were provided by 1,363 paid and volunteer firefighters in 1995. The fire district with the highest firefighter-to-population ratio was located in Bamberg County, 9.3 firefighters per 1,000 persons, as indicated in Figure 3.7.8–4. Aiken County employed the greatest number of firefighters (375). The average firefighter-to-population ratio in the ROI was 3.0 firefighters per 1,000 persons.

Health Care. There were eight hospitals serving the six-county ROI in 1994. Figure 3.7.8–4 displays the hospital bed-to-population ratios for the SRS ROI counties. During 1994, all hospitals were operating below capacity, with hospital occupancy rates ranging from 45.7 percent in Barnwell County to 73.8 percent in Bamberg County.

In 1994, a total of 1,360 physicians served the ROI, with the majority (985) located in Richmond County. Figure 3.7.8–4 shows that the physician-to-population ratios for the ROI ranged from 0.4 physicians per 1,000 persons in Barnwell County to 5.0 physicians per 1,000 persons in Richmond County. The average ROI physician-to-population ratio was 3.0 physicians per 1,000 persons.

Local Transportation. The SRS is served by more than 322 km (200 mi) of primary roads and more than 1,609 km (1,000 mi) of unpaved secondary roads (see Figure 2.2.6–1 and Figure 2.2.6–2). The primary highways used by SRS commuters are State Routes 19, 64, and 125. There are no current or planned road improvements that would affect SRS.

Two road segments in the ROI could be affected by the storage and disposition alternatives. The first is South Carolina State Route 19 from U.S. 1/78 at Aiken to U.S. 278. This segment operated at level of service E in 1995. The second is South Carolina State Route 230 from U.S. 25 Business at North Augusta to U.S. 1/25/78/278. This segment operated at level of service E in 1995.

There is no public transportation to SRS (SR DOT 1995a:1). Rail service in the ROI is provided by the Norfolk Southern Corporation and CSX Transportation. SRS is provided rail access via Robbins Station on the CSX Transportation line. In addition, SRS maintains 101 km (63 mi) of onsite track for internal uses (DOE 1993j:4-60).

Waterborne transportation is available via the Savannah River. Currently, the Savannah River is used primarily for recreation (DOE 1993j:4-60). SRS has no commercial docking facilities, but it has a boat ramp that has accepted large transport barge shipments (SRS 1995a:9.)

Columbia Metropolitan Airport in the city of Columbia, South Carolina and Bush Field in the city of Augusta, Georgia, receive jet air passenger and cargo service from both national and local carriers. Numerous smaller private airports are located in the ROI.

3.7.9 PUBLIC AND OCCUPATIONAL HEALTH AND SAFETY

Radiation Environment. Major sources and levels of background radiation exposure to individuals in the vicinity of SRS are shown in Table 3.7.9–1. Annual background radiation doses to individuals are expected to remain constant over time. The total dose to the population changes as the population size changes. Background radiation doses are unrelated to SRS operations.

Table 3.7.9–1. Sources of Radiation Exposure to Individuals in the Vicinity, Unrelated to Savannah River Site Operation

Source	Effective Dose Equivalent (mrem/yr)
Natural Background Radiation[a]	
Cosmic and cosmogenic radiation	29
External radiation	29
Internal terrestrial radiation	40
Radon in homes (inhaled)	200
Other Background Radiation[b]	
Diagnostic x rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	363

[a] WSRC 1994d.
[b] NCRP 1987a.
Note: Value for radon is an average for the United States.

Releases of radionuclides to the environment from SRS operations provide another source of radiation exposure to individuals in the vicinity of SRS. Types and quantities of radionuclides released from SRS operations in 1993 are listed in the *Savannah River Site Environmental Report* for 1993 (WSRC-TR-94-075). The doses to the public resulting from these releases are presented in Table 3.7.9–2. These doses fall within radiological limits (DOE Order 5400.5) and are small in comparison to background radiation. The releases listed in the 1993 report were used in the development of the reference environment (No Action) radiological releases and resulting impacts at SRS in the year 2005 (Section 4.2.6.9).

Based on a risk estimator of 500 cancer deaths per 1 million person-rem to the public (Section M.2.1.2), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from SRS operations in 1993 is estimated to be 1.6×10^{-7}. That is, the estimated probability of this person dying of cancer at some point in the future from radiation exposure associated with 1 year of SRS operations is less than 2 in 10 million. (Note that it takes several to many years from the time of radiation exposure for a cancer to manifest itself.)

Based on the same risk estimator, 0.011 excess fatal cancers are projected in the population living within 80 km (50 mi) of SRS from normal operations in 1993. To place this number into perspective, it can be compared with the number of fatal cancers expected in this population from all causes. The 1990 mortality rate associated with cancer for the entire U.S. population was 0.2 percent per year (Almanac 1993a:839). Based on this national mortality rate, the number of fatal cancers from all causes expected during 1993 in the population living within 80 km (50 mi) of SRS was 1,240. This number of expected fatal cancers is much higher than the estimated 0.011 fatal cancers that could result from SRS operations in 1993.

Table 3.7.9–2. Radiation Doses to the Public From Normal Savannah River Site Operation in 1993 (Committed Effective Dose Equivalent)

Members of the General Public	Atmospheric Releases		Liquid Releases		Total	
	Standard[a]	Actual	Standard[a]	Actual[b]	Standard[a]	Actual
Maximally exposed individual (mrem)	10	0.18	4	0.14	100	0.32
Population within 80 km[c] (person-rem)	None	20.0	None	1.5	100	21.5
Average individual within 80 km[d] (mrem)	None	0.032	None	0.0022	None	0.034

[a] The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10 mrem/yr limit from airborne emissions is required by the CAA, the 4 mrem/yr limit is required by the SDWA, and the total dose of 100 mrem/yr is the limit from all pathways combined. The 100 person-rem value for the population is given in proposed 10 CFR 834 (58 FR 16268). If the potential total dose exceeds this value, it is required that the contractor operating the facility notify DOE.

[b] The actual dose value given in the column under liquid releases conservatively includes all water pathways, not just the drinking water pathway. The population dose includes contributions to Savannah River users downstream of SRS to the Atlantic Ocean.

[c] In 1993, this population was approximately 620,100. For liquid releases, an additional 65,000 water users in Port Wentworth, Georgia and Beaufort, South Carolina (approximately 160 km downstream) are included in the assessment.

[d] Obtained by dividing the population dose by the number of people living within 80 km of the site for atmospheric releases; for liquid releases the number of people includes water users who live more than 80 km downstream of the site.

Source: WSRC 1994d.

The SRS workers receive the same dose as the general public from background radiation, but also receive an additional dose from working in the facilities. Table 3.7.9–3 presents the average worker, maximally exposed worker, and cumulative worker dose to SRS workers from operations in 1992. These doses fall within radiological regulatory limits (10 CFR 835). Based on a risk estimator of 400 fatal cancers per 1 million person-rem among workers (Section M.2.1.2), the number of fatal cancers to SRS workers from normal operations in 1992 is estimated to be 0.14.

Table 3.7.9–3. Radiation Doses to Workers From Normal Savannah River Site Operation in 1992 (Committed Effective Dose Equivalent)

Occupational Personnel	Onsite Releases and Direct Radiation	
	Standard[a]	Actual
Average worker (mrem)	ALARA	17.9
Maximally exposed worker (mrem)	5,000	3,000
Total workers[b] (person-rem)	ALARA	350

[a] DOE's goal is to maintain radiological exposures as low as reasonably achievable.

[b] The number of badged workers in 1992 was approximately 19,500.

Source: 10 CFR 835, DOE 1993n:7.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the *Savannah River Site Environmental Report* for 1993 (WSRC-TR-94-075).

The concentrations of radioactivity in various environmental media (including air, water, and soil) in the site region (onsite and offsite) are also presented in this reference.

Chemical Environment. The background chemical environment important to human health consists of the atmosphere, which may contain hazardous chemicals that can be inhaled; drinking water, which may contain hazardous chemicals that can be ingested; and other environmental media with which people may come in contact (for example, surface waters during swimming and soil through direct contact or via the food pathway). The baseline data for assessing potential health impacts from the chemical environment are those presented in Section 3.7.3.

Effective administrative and design controls that decrease hazardous chemical releases to the environment and help achieve compliance with permit requirements (for example, air emissions and NPDES permit requirements), contribute toward minimizing potential health impacts to the public. The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts to the public may occur during normal operations at SRS via inhalation of air containing hazardous chemicals released to the atmosphere by SRS operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water, or direct exposure, are low relative to the inhalation pathway.

Baseline air emission concentrations for hazardous chemicals and their applicable standards are included in the data presented in Section 3.7.3. These concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. These concentrations are in compliance with applicable guidelines and regulations. Information about estimating health impacts from hazardous chemicals is presented in Section M.3.

Exposure pathways to SRS workers during normal operations may include inhaling the workplace atmosphere and direct contact with hazardous materials associated with work assignments. The potential for health impacts varies from facility to facility and from worker to worker, and available information is not sufficient to allow a detailed estimation and summation of these impacts. However, the workers are protected from hazards specific to the workplace through appropriate training, protective equipment, monitoring, and management controls. SRS workers are also protected by adherence to OSHA and EPA standards that limit workplace atmospheric and drinking water concentrations of potentially hazardous chemicals. Appropriate monitoring that reflects the frequency and amounts of chemicals utilized in the operational processes ensures that these standards are not exceeded. Additionally, DOE requirements ensure that conditions in the workplace are as free as possible from recognized hazards that cause or are likely to cause illness or physical harm. Therefore, worker health conditions at SRS are expected to be substantially better than required by the standards.

Health Effects Studies. Only one published epidemiological study on the general population in communities surrounding SRS has been conducted. No evidence of excess cancer mortality, congenital anomalies, birth defects, early infancy deaths, strokes, or cardiovascular deaths was reported. An excess in leukemia deaths has been reported among hourly workers at SRS; no other health effects for workers were reported in the literature and reports reviewed. For a more detailed description of the studies reviewed and the findings, refer to Section M.4.7.

Accident History. Between 1974 and 1988, there were 13 inadvertent tritium releases from the tritium facilities at SRS. These releases have been traced to aging equipment in the tritium processing facility and are one of the reasons for the construction of a Replacement Tritium Facility at SRS. A detailed description and study of these incidents and their consequences to the offsite population has been documented by SRS. The most significant were in 1981, 1984, and 1985 when 32,934, 43,800, and 19,403 Ci of tritiated water vapor, respectively, were released (WSRC 1991a:41). In the period 1989 through 1992 there were 20 inadvertent releases, all with little or no offsite dose consequences. The largest of these recent releases occurred in 1992 when 12,000 Ci of tritium were released (WSRC 1993a:260).

In 1993, an inadvertent release of Pu-238 and Pu-239 took place. Westinghouse Savannah River Company (WSRC) emergency response models estimated a hypothetical exposure of 0.0019 mrem at the site boundary (WSRC 1994d:182).

Emergency Preparedness. Each DOE site has established an emergency management program that would be activated in the event of an accident. This program has been developed and maintained to ensure adequate response for most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program incorporates activities associated with emergency planning, preparedness, and response.

The Emergency Preparedness Facility at SRS provides overall direction and control for onsite responses to emergencies and coordinates with Federal, State, and local agencies and officials on the technical aspects of the emergency.

The SRS Emergency Operations Facility consists of several centers, described below, that provide distinct emergency response support functions:

- The SRS Operations Center coordinates the initial response to all SRS emergencies and is equipped to function as the heart of SRS's emergency response communications network.

- The Technical Support Center provides command and control of emergency response activities for the affected facility or operational area.

- The Emergency Operations Center provides command and control of emergency response activities for SRS locations outside of the affected area.

- The Security Management Center coordinates activities relating to the security and safeguarding of materials by providing security staff in the affected area and contractor management in the Emergency Operations Center.

- The Dose Assessment Center is responsible for assessing the health and environmental consequences of any airborne or aqueous releases of radioactivity or toxic chemicals and recommends onsite and offsite protective actions to other centers.

3.7.10 WASTE MANAGEMENT

This section outlines the major environmental regulatory structure and ongoing waste management activities for SRS. A more detailed discussion of the ongoing waste management operations is provided in Section E.2.6. Table 3.7.10–1 presents a summary of waste management activities at SRS for 1993.

The Department is working with Federal and State regulatory authorities to address compliance and cleanup obligations arising from its past operations at SRS. The DOE 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.

The EPA has placed SRS on the NPL and has identified approximately 150 potential operable units. In accordance with CERCLA, DOE entered into an FFCA with the EPA and the State of South Carolina, effective January 15, 1993, to coordinate cleanup activities at SRS under one comprehensive strategy. The FFCA combines the RCRA Facility Investigation Program Plan (under RCRA) with a CERCLA cleanup program entitled the RCRA Facility Investigation/Remedial Investigation Program Plan.

The Savannah River Site has an aggressive waste minimization program in progress to vastly improve the operation of existing and planned liquid and solid waste generating, treatment, and storage facilities. A disciplined approach to these activities is being developed based on technology and experience from the commercial nuclear industry. This approach already has significantly reduced the generation of TRU waste (48 percent), LLW (13 percent), mixed waste (96 percent), and hazardous waste (58 percent) (DOE 1993e:I-18). SRS generates and manages spent nuclear fuel and the following waste categories: high-level, TRU, low-level, mixed, hazardous, and nonhazardous. A discussion of the waste management operations associated with each of these categories follows.

Spent Nuclear Fuel. With the shutdown of the production reactors at SRS, no new spent nuclear fuel is expected to be generated from existing SRS operations. Future receipt and management of spent nuclear fuel at SRS will be made in accordance with the ROD published in the *Federal Register* (60 FR 28680) on June 1, 1995, and amended on March 8, 1996 (61 FR 9441) for the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE/EIS-0203-F), and the ROD (61 FR 25092) for the EIS on the *Proposed Policy for the Acceptance of U.S. Origin Foreign Research Reactor Spent Nuclear Fuel* (DOE/EIS-0218F).

High-Level Waste. Liquid HLW at SRS is made up of many waste streams generated during the recovery and purification of TRU products and unburned fissile material from spent reactor fuel elements. These wastes are separated by waste form, radionuclide, and heat content before their transfer to underground storage tanks in the F- and H-Area tank farms. Processes used routinely to treat liquid HLW are separation, evaporation, and ion exchange. Evaporation produces a Cs-contaminated condensate. Cesium is removed from the condensate resulting in a LLW stream that is treated in the ETF. The remaining HLW stream salts are precipitated, and some can be decontaminated. The decontaminated salt solution is sent with residues from the ETF to the Defense Waste Processing Z-Area Saltstone Facility where it is mixed with a blend of cement, flyash, and blast furnace slag to form grout. The grout is pumped into disposal vaults where it hardens for permanent disposal as solid LLW. The remaining high-level salt and sludge is permanently immobilized as a glass solid cast in stainless steel containers at the DWPF Vitrification Plant. The stainless-steel containers are decontaminated to DOT standards, welded closed, and temporarily stored onsite for eventual transport to and disposal in a permanent Federal repository. Future HLW generation could result from the processing and stabilization of spent fuel for long-term storage as a result of 60 FR 28680, and from remediation or materials recovery activities performed in the F- and H-Canyons.

Table 3.7.10–1. Spent Nuclear Fuel and Waste Management Activities at Savannah River Site

Category	1993 Generation (m^3)	Treatment Method	Treatment Capacity (m^3/yr)	Storage Method	Storage Capacity (m^3)	Disposal Method	Disposal Capacity (m^3)
Spent Nuclear Fuel	None	Stabilization[a]	None[a]	Pools	Sized to current inventory	None–High-Level Waste Program in the future	NA
High-Level							
Liquid	1,561	Settle,separate, evaporate	53,700[b]	F- & H- Area Tank Farm	133,000[c]	NA[d]	NA
Solid	None	Vitrification[e]	None	Air Cooled Shielded Facility	2,286 canisters[f]	None–High-Level Waste Program in the future	NA
Transuranic							
Liquid	None	NA	NA	NA	NA	NA	NA
Solid	391	None	None	Pads, buildings	14,600[g]	None–WIPP or alternate facility in the future	None
Low-Level							
Liquid	None	Absorption, evaporation, filtration, neutralization, saltstone	503,000[h]	Ponds, tanks-awaiting processing	NA	NA	NA
Solid	14,100	Compaction	3,980[i]	NA	NA	Burial vaults and trenches	2,578,000[j]
Mixed Low-Level							
Liquid	115	Stabilization, adsorption, neutralization, precipitation, filtration, ion exchange, evaporation	511,000[k]	RCRA permit Bldgs. E, 600, 700, M-Area Liquid Effluent Treatment Facility	11,500[l]	None	None
Solid	18	None	NA	RCRA permit Bldg. 600	1,990[m]	None	None
Hazardous							
Liquid	None	None	None	DOT containers	Included in solid	Offsite	NA
Solid	74[n]	None	None	DOT containers	2,618[o]	Offsite	NA

Table 3.7.10–1. Spent Nuclear Fuel and Waste Management Activities at Savannah River Site—Continued

Category	1993 Generation (m^3)	Treatment Method	Treatment Capacity (m^3/yr)	Storage Method	Storage Capacity (m^3)	Disposal Method	Disposal Capacity (m^3)
Nonhazardous (Sanitary)							
Liquid	700,000[p]	Filter, settle, strip	1,451,000[q]	Flowing ponds	NA	Permitted discharge	Varies by each permitted outfall
Solid	6,670	Compaction	Expandable, as required	NA	NA	Landfill (onsite and offsite)	Expandable, as required
Nonhazardous (Other)							
Liquid	Included in sanitary	Included in sanitary	Included in sanitary	Included in sanitary	NA	Included in sanitary	Included in sanitary
Solid	Included in sanitary	Included in sanitary	Included in sanitary	NA	NA	Included in sanitary	Included in sanitary

[a] Some fuel will be processed in the F- and H-Canyons in accordance with the Final Environmental Impact Statement, *Interim Management of Nuclear Materials*.
[b] SRTC ion exchange, evaporators.
[c] F- and H-Area Tank Farms.
[d] Treatment removes the high level constituents (salt and sludge) from the liquids. The salt and sludge are vitrified.
[e] DWPF started operation in 1995.
[f] Defense Waste Processing Facility.
[g] TRU storage pads.
[h] Includes F- and H-Area Effluent Treatment Facility.
[i] Onsite compactors.
[j] Saltstone vaults, E-Area vaults, slit trenches.
[k] Includes F- and H-Area Effluent Treatment Facility, M-Area Effluent Treatment Facility, and Savannah River Technology Center Ion-exchange Treatment.
[l] Hazardous Waste Storage Facility, mixed waste storage buildings, Process Waste Interim Treatment, DWPF organic waste storage tank, burial ground storage tank, SRTC mixed waste storage.
[m] Hazardous Waste Storage Facility, mixed waste storage buildings.
[n] SRS generated 64.93 t of RCRA-regulated and 8.90 t TSCA-regulated hazardous wastes; thus, the sum is approximately 74 t. Assuming a density of 1,000 kg/m^3, a volume of 74 m^3 was calculated.
[o] Pads and buildings in B-, M-, and N-Areas.
[p] 1991 data.
[q] Centralized Sanitary Wastewater Treatment Facility.
Note: NA=not applicable.
Source: DOE 1995kk; SR DOE 1993c; SR DOE 1994b; SR DOE 1994c; SR DOE 1995b; SR DOE 1995c; SR MMES 1993a; SRS 1995a:2; WSRC 1995a.

Transuranic Waste. Under the FFCA on RCRA, LDRs signed by EPA and DOE on March 13, 1991, SRS is required to prepare TRU waste for shipment. SRS will begin discussions with the South Carolina Department of Health and Environmental Control on alternative treatment options in January 1998 if the Secretary of Energy does not decide to operate WIPP by that time. If a delayed opening date for WIPP is determined, DOE will propose modifications to the *SRS Site Treatment Plan* for approval by the State of South Carolina. Status of the WIPP readiness schedule will be included in the updates. Certified TRU waste is stored on TRU waste storage pads until it can be shipped to an approved TRU waste disposal facility. Should additional treatment be necessary for disposal, SRS would develop the appropriate treatment capability. All TRU waste currently generated is stored in containers on aboveground pads.

The Experimental TRU Waste Assay and Certification Facility began operations in 1986 to certify newly generated TRU waste. It since has been shut down. A new TRU waste characterization and certification facility is planned, and would provide extensive containerized waste processing certification capabilities. The facility is needed to prepare TRU waste for treatment and to certify TRU waste for disposal at WIPP. Drums that can be certified for shipment to WIPP are placed in interim storage on concrete pads in E-Area. Buried and stored waste containing concentrations of TRU nuclides between 10 and 100 nanocuries (nCi)/g (referred to as alpha-contaminated LLW or alpha waste) is managed like TRU waste because its physical and chemical properties are similar, and because similar procedures will be used to determine its final disposition. Because all of the TRU waste placed on the aboveground pads prior to January 1990 is suspected of having hazardous constituents, a RCRA Part B permit application has been submitted for the TRU waste storage pads and the Experimental TRU Waste Assay Certification Facility. The waste is currently being stored under RCRA interim status.

Low-Level Waste. The bulk of liquid LLW is aqueous process waste, including effluent cooling water, decontaminated salt solutions, purge water, water from storage basins for irradiated reactor fuel or target elements, distillate from the evaporation of process waste streams, and surface water runoff from areas where there is a potential for radioactive contamination. Liquids are processed to remove and solidify the radioactive constituents and to release the balance of the liquids to permitted discharge points within standards established by the regulatory permit. Solid LLW includes operating plant and laboratory waste, contaminated equipment, reactor and reactor-fuel hardware, spent lithium-aluminum targets, and spent deionizer resin from reactor coolant treatment. Solid LLW is separated by radiation levels into low and intermediate categories. Solid LLW that radiates less than 200 mrem/hr at 5 cm (1.97 in) from the unshielded container is considered low-activity waste. If it radiates greater than 200 mrem/hr at 5 cm (1.97 in), it is considered intermediate-activity waste. Intermediate-activity tritium waste is intermediate-activity waste with greater than 10 Ci of tritium per container. The disposal mode for solid LLW is disposal in earthen trenches and concrete vaults. Saltstone generated in the solidification of decontaminated salts extracted from HLW is disposed of as LLW in separate vaults. Saltstone is the highest volume of solid LLW disposed of at SRS. Disposal facilities are projected to meet solid LLW storage/requirements and to include LLW from offsite DOE facilities for the next 20 years.

Mixed Low-Level Waste. The FFCA signed by EPA and DOE on March 13, 1991, addresses SRS compliance with RCRA LDRs pertaining to past, ongoing, and future generation of mixed LLW (mostly solvents, dioxin, and California list wastes contaminated with tritium). SRS is allowed to continue to operate, generate, and store mixed wastes subject to LDRs; in return, SRS will report to EPA the characterization of all solid waste streams disposed of in land disposal units at SRS and has submitted its waste minimization plan to EPA for review. Schedules for measures to provide compliance through construction of the Consolidated Incineration Facility and the Hazardous Waste and Mixed Waste Storage Facility are included in the FFCA.

The Consolidated Incineration Facility will treat mixed LLW and hazardous waste. The Hazardous Waste and Mixed Waste Disposal Vaults are scheduled to be available in 2002. Mixed waste is currently placed in interim storage in the E-Area Solid Waste Disposal Facility and in two buildings in G-Area. These RCRA-permitted facilities will be used until completion of the Consolidated Incineration Facility and the Hazardous Waste and Mixed Waste Storage Facility. The FFCA requires DOE facilities storing mixed waste to develop site-specific treatment plans and to submit the plans for approval. The FFCA formed the basis for the *SRS Proposed Site Treatment Plan.*

Hazardous Waste. Lead, mercury, cadmium, 1,1,1-trichloroethane, leaded oil, trichlorotrifluoroethane, benzene, and paint solvents are typical hazardous wastes generated at SRS. All hazardous wastes are stored onsite in DOT-approved containers in RCRA-permitted facilities in three RCRA-permitted hazardous waste storage buildings and on three interim status storage pads in the B- and N-Areas. Most of the waste is shipped offsite to commercial RCRA-permitted treatment and disposal facilities using DOT-certified transporters. Eight to nine percent of the hazardous waste (organic liquids, sludge and debris) will be incinerated in the Consolidated Incineration Facility. Hazardous chemicals are stripped from aqueous liquids collected during groundwater monitoring in the M-Area Stripper, and the treated wastewater is discharged in accordance with discharge limits of appropriate NPDES permits.

Nonhazardous Waste. In 1994, the centralization and upgrading of the sanitary wastewater collection and treatment systems at Savannah River were completed. The program included the replacement of 14 aging treatment facilities (out of 20) scattered across the site with a new 3,975 m^3/day (1.05 million gal/day) central treatment facility and connecting them with a new 29-km (18-mi) primary sanitary collection system. The collection system intercepts wastewater at points prior to discharge into old sanitary wastewater treatment facilities. The new central treatment facility treats sanitary wastewater by the extended aeration activated sludge process utilizing the oxidation ditch method. The treatment facility separates the wastewater into two forms, clarified effluent and sludge. The liquid effluent is further treated by non-chemical methods of ultraviolet light disinfection to meet NPDES discharge limitations. The sludge goes through a volume reduction process to reduce pathogen levels to meet proposed land application criteria (40 CFR 503). The remaining existing sanitary wastewater treatment facilities are being upgraded as necessary to meet demands by replacing existing chlorination treatment systems with non-chemical ultraviolet light disinfection systems to meet NPDES limitations. SRS-generated municipal solid waste is sent to a permitted offsite disposal facility. DOE is evaluating a proposal to participate in an interagency effort to establish a regional solid waste management center at SRS (DOE/EA-0989, DOE/EA-1079).

3.8 ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

Rocky Flats Environmental Technology Site was established in 1952 by the AEC and is located in rural northern Jefferson County, Colorado, 26 km (16 mi) northwest of downtown Denver and about 19 km (12 mi) south of Boulder. Once a remote site, RFETS is now adjacent to a large and growing metropolitan area that includes the communities of Boulder, Arvada, Westminster, Broomfield, and Golden. The Rocky Flats Industrial Area occupies approximately 155 ha (384 acres) in the middle of the site. The remaining 2,495 ha (6,165 acres) form a buffer zone around the active part of RFETS. The buffer zone provides a distance of more than 1.6 km (1 mi) between the developed portion of the site and any public road or private property.

The RFETS mission is to transition from a production-dominated site to an environmental restoration, cleanup, and waste management-dominated site. The contingency status of buildings that could have been used to manufacture new Pu components has been removed. The site will retain a Pu storage mission pending decisions and actions regarding long-term Pu storage and disposition based on this PEIS. The DOE property boundaries for the site are illustrated in Figure 2.2.7–1. The locations of major Pu facilities at RFETS are shown in Figure 2.2.7–2. Current activities at RFETS are all related to DOE activities. RFETS missions are listed in Table 3.8–1.

Table 3.8–1. Current Missions at Rocky Flats Environmental Technology Site

Mission	Description	Sponsor
Interim Pu storage	Maintain Buildings 371, 559, 707, 776/777, and 771 for interim Pu storage, with eventual consolidation into a single facility.	Assistant Secretary for Environmental Management
RFETS environmental restoration and waste management	As buildings are released from DP control, decontaminate and decommission; remove all Pu and other toxic and/or hazardous materials; prepare Pu wastes for final transport to long-term storage facility.	Assistant Secretary for Environmental Management

Source: RFETS 1995a:1.

Department of Energy Activities. With the January 1992 Presidential decision to cancel W88 warhead production, there are currently no weapons-related Pu operations scheduled for RFETS. The site will continue its Pu storage function, employing existing buildings for nonsurplus and surplus Pu materials. Pu component fabrication and production support activities have been permanently stopped; any such future activities would take place at other DOE sites. Other RFETS DOE activities that have been relocated under the nonnuclear manufacturing consolidation include the following:

- Manufacturing, fabrication, and repair support for the safe secure tractors, trailers, and railcars of the DOE transportation safeguards activities
- Fabrication of nuclear weapon component and assembly training devices, used by both DOE and the DoD
- Reservoir production that involves fabricating, assembling, testing, inspecting, and shipping of gas reservoir assemblies
- Metrology services
- Nuclear-grade steel

The expected reduction in stockpile requirements would have allowed Pu recovered from retired weapons to be recycled for all new production needs. Current stockpile projections anticipate that larger quantities of Pu will be returned from weapon disassembly activities. Consequently, all existing residues, wastes, and Pu oxides do not need to be reprocessed for future weapon production at this time. These materials would only be processed to the extent necessary to ensure their stability for long-term monitored, retrievable storage or transport off the RFETS site in a Pu metal or oxide form. Selection of disposition options for residues would be based on minimizing waste disposal costs.

The current RFETS long-term mission is to prepare Pu processing and fabrication facilities for D&D with final disposition by EM. The Pu storage mission involves materials designated as either strategic reserve for current or anticipated program needs, surplus that can be converted to stable metal or oxide forms for storage and transport, or residue that is destined for disposal as waste. Pu storage capabilities would be maintained in Buildings 371, 707, 771, 776/777, and 559, with eventual consolidation into a single facility.

While preparing for PEIS ROD implementation, this interim period without Pu processing will permit operating selected RFETS Pu processing facilities to support the environmental restoration mission. Individual buildings and facilities will be D&D in accordance with EM plans.

The primary mission of RFETS was to produce components for nuclear weapons from materials such as Pu, uranium, beryllium, and various alloys of stainless steel. Production was stopped in 1989, and up until that time plant operations and purposes were kept secret, with little mission and management information given to the public. The site was off-limits to the general public. In 1992, the plant's production of nuclear weapon components was officially discontinued with the end of the Cold War.

Rocky Flats Environmental Technology Site now has a new mission focusing on environmental restoration, waste management, management of special nuclear materials onsite (one of which is Pu), D&D of facilities, and economic development. Although the site remains off-limits to the general public due to health and safety considerations, DOE now provides extensive information to the public concerning management and operations and works closely with the public on many issues related to RFETS.

Non-Department of Energy Activities. The RFETS has no non-DOE activities at this time.

3.8.1 LAND RESOURCES

Land Use. The 2,650-ha (6,550-acre) RFETS is located in northern Jefferson County, Colorado, approximately 26 km (16 mi) northwest of downtown Denver. All land within RFETS is owned by the Federal Government and is administered, managed, and controlled by DOE.

Existing Land Use. Generalized land uses within RFETS and the immediate vicinity are shown in Figure 3.8.1–1. Land uses surrounding the site are primarily open space, industrial, and rural residential and agricultural (grazing and hay production) (RF EG&G 1993a:2-1). RFETS contains two major categories of land use: industrial and undeveloped. Production facilities occupy approximately 155 ha (384 acres), or 6 percent of the site, and are centrally located on the site (RF DOE 1994a:2). The approximately 2,495 ha (6,165 acres) that remains is utilized as a security buffer zone while most of this area is open space (undeveloped); however, there are several other uses, including approximately 8 ha (20 acres) of production support facilities, approximately 45 ha (111 acres) of sanitary waste disposal, and 211 ha (523 acres) of aggregate and clay mining. No prime farmland exists onsite. There are no public recreation facilities onsite.

Land-Use Planning. Planning does not occur at the state level within Colorado, however, regional planning within the RFETS vicinity occurs through advisory Denver Regional Council of Governments (DRCOG). RFETS is located within Jefferson County, one of six counties that compromise the DRCOG. Jefferson County does not currently have a countywide comprehensive plan, however, the county has adopted community plans. Community plans function as land-use plans for specific areas of the county and their recommendations are used for making and granting future land-use decisions. The North Plains Community Plan designates RFETS as a "Special Use Area." The zoning resolution for Jefferson County classifies RFETS land with the following zoning districts: agricultural, industrial, and special use.

Visual Resources. The RFETS lays amid a landscape that is mostly grazing land with low hills and ridges. Construction and operation of the DOE facilities has heavily disturbed the character of the landscape. The most dominant features of the site include two large stacks and a water tank. The existing facilities are separated from public roads by the open land in the buffer area. The Rocky Mountains start to rise approximately 3.2 km (2 mi) to the west of RFETS. Because access to the site is limited to authorized personnel, public visual access is limited to views from the outside (RF EG&G 1993a:3-22). The facilities are brightly lit at night and are highly visible from many areas within a 4.8- to 8-km (3- to 5-mi) radius of the site. The area within the central developed area is consistent with a VRM Class 5 designation. The remainder of the site ranges from VRM Class 3 to Class 4.

3.8.2 SITE INFRASTRUCTURE

Baseline Characteristics. Activities at RFETS are concentrated in facilities in the middle of the site. To support these activities, an extensive infrastructure exists. Baseline site infrastructure characteristics are shown in Table 3.8.2–1.

Table 3.8.2–1. Rocky Flats Environmental Technology Site Baseline Characteristics

Characteristics	Current Usage	Site Availability
Transportation		
Roads (km)	40	40
Railroads (km)	5	5
Electrical		
Energy consumption (MWh/yr)	184,000	184,000
Peak Load (MWe)	26	26
Fuel		
Natural gas (m^3/yr)	18,600,000	18,600,000
Oil (l/yr)	8,140,000	8,140,000
Coal (t/yr)	0	0
Steam (kg/hr)	41,000	41,000

Source: RFETS 1995a:1.

Two-lane county and State highways circumvent the site and include State Route 93 to the west, State Route 128 to the north, and Indiana Street to the east. No roads exist along the southern boundary and no public access roads traverse the site. RFETS has controlled access gates to the east and west with a paved road running through the middle of the site connecting Route 93 to Indiana Street. The site also has numerous dirt firebreak and access roads for management. Nuclear wastes from RFETS are transported by truck primarily along the interstate highway system. Nuclear shipments are restricted to off-peak periods when traffic activity is low.

Normal and alternate power is supplied from the Public Service Company of Colorado through two electrical switching stations. Currently, one station (to the north of the site) is used for primary services, and the other (just outside the west gate) is used to supply a small portion of the western side of the site and as backup electrical power. Emergency diesel generators provide backup power capabilities should normal and alternate power be lost. The sub-regional electric power pool from which RFETS draws its power is the Rocky Mountain Power Area. Capabilities of this power pool are summarized in Table 3.8.2–2.

The site is connected to a Public Service Company natural gas line. The line passes through the site and continues west to serve residential customers in the Coal Creek canyon area.

There are two methods by which the site acquires water; the method used at any particular time is at the discretion of the Denver Water Board. The preferred supply comes from a diversionary canal between Gross and Ralston Reservoirs. The canal passes the site between the west gate and Route 93, and provides gravity-fed flow to a holding pond, also to the west of the site. The second method involves pumping water directly from Ralston Reservoir to the holding pond, overcoming more than 300 ft of head pressure.

Table 3.8.2–2. Rocky Mountain Area Sub-Regional Power Pool Electrical Summary

Characteristics	Energy Production
Type Fuel	
Coal	71%
Nuclear	0%
Hydro/geothermal	15%
Oil/gas	5%
Other[a]	9%
Total Annual Production	52,781,000 MWh
Total Annual Load	49,936,000 MWh
Energy Exported Annually[b]	2,753,000 MWh
Generating Capacity	10,691 MWe
Peak Demand	7,861 MWe
Capacity Margin[c]	2,357 MWe

[a] Includes power from both utility and nonutility sources.

[b] Energy exported is not the difference of production and load due to negative net pumped storage.

[c] Capacity margin is the amount of generating capacity available to provide for scheduled maintenance, emergency outages, system operating requirements, and unforeseen electrical demand.

Source: NERC 1993a.

The locations of buildings at RFETS are shown in Figure 2.2.7–2; the buildings that play a role in the site EA's proposed Category I and II special nuclear material consolidation and interim storage program are highlighted. Buildings 371 and 707 would play the most active role in the proposed site-specific action while Buildings 771, 776/777, 779, and 991 would perform consolidation support functions. The remainder of this section provides a description of these buildings. With the exception of Building 371, all of the buildings were built to commercial industrial standards. Building 371 was built to strict nuclear design standards.

Building 371 currently stores Category I and II special nuclear material and is proposed to be the primary special nuclear material consolidation and interim storage facility until long-term storage and disposition actions are decided and implemented. Portions of the RFETS Pu residues, TRU waste, and RCRA waste inventories currently are stored in Building 371. The four-level facility has approximately 17,300 m^2 (186,000 ft^2) of floor space and contains six Pu storage vaults and vault-type rooms. The stacker/retriever moves radioactive materials between the central storage vault and the input and output stations. In addition to this transport capability, the central storage vault was designed for storage of Category I and II special nuclear material.

Building 707 is a two-story facility with 6,897 m^2 (74,240 ft^2) per floor. A single-story portion with 1,724 m^2 (18,560 ft^2) composes the east side of the building. The building contains 10 modules in which various manufacturing activities have taken place in the past. Building 707 is connected directly, through other buildings or by tunnels, to Buildings 776/777, 771, 778, and 779.

Building 771 is a two-level facility with approximately 14,000 m^2 (151,000 ft^2) of floor space and stores Pu that requires stabilization. The building is connected by a tunnel to Building 776/777, which is directly connected to Buildings 779 and 707. The tunnel between Buildings 771 and 776 is concrete-lined and is equipped with a HEPA filtration ventilation system.

Building 776/777 is a two-story facility with approximately 14,500 m^2 (156,200 ft^2) of floor space and contains special nuclear material that requires stabilization. The building is connected to Building 779 by an enclosed hallway, to Building 771 by tunnel, and to Building 707 via Building 778.

Building 779 is a research and development facility originally built to support production and recovery processes. The facility was completed in 1965, and the external structure was subsequently improved to withstand an earthquake of 6.0 on the Richter scale.

Building 991 was built in 1952 and is used primarily for shipping special nuclear material and other certified product materials (including nonnuclear materials). The facility and its associated underground tunnels and vaults are also used for storing special nuclear material and other certified product materials.

3.8.3 AIR QUALITY AND NOISE

Meteorology and Climatology. The RFETS region is characterized as a dry climate, middle-latitude steppe, with mild, sunny, semiarid conditions and few temperature extremes. The average annual temperature at RFETS is 10.2 °C (50.3 °F); temperatures vary from an average daily minimum of -8.8 °C (16.1 °F) in January to an average daily maximum of 31.2 °C (88.2 °F) in July. The average annual precipitation at RFETS is 39.1 cm (15.4 in). The average annual windspeed at Denver National Weather Service Station is 3.8 m/s (8.6 mph) (NOAA 1994a:3). Additional information related to meteorology and climatology at RFETS is presented in Appendix F.

Ambient Air Quality. The RFETS is located within the Metropolitan Denver Intrastate AQCR #36. This AQCR is designated nonattainment with respect to the NAAQS for PM_{10}, O_3, and CO, and listed as attainment for SO_2 and NO_2 (40 CFR 81.306). The PM_{10} standard is exceeded primarily due to fugitive dust. Vehicular traffic is a major contributor to the high concentrations of O_3 and CO in the region. Applicable NAAQS and the ambient air quality standards for Colorado are presented in Appendix F.

Since the creation of the PSD program in 1977, PSD permits have not been required for any new RFETS emission sources. There are several PSD (40 CFR 52.21) Class I areas near RFETS. The closest, Rocky Mountain National Park, is located approximately 46 km (30 mi) northwest of RFETS.

The emissions inventory from sources at RFETS is presented in Appendix F. Historically the principal sources of criteria pollutants at RFETS are the steam plant boilers. Minor combustion sources include various small boilers and diesel generators. Other sources of criteria pollutants include coating operations and particulate matter from various manufacturing operations.

National hazardous and toxic air pollutant standards have not been adopted by the State of Colorado Department of Public Health and Environment. The annual emission rates of hazardous/toxic air pollutants from existing RFETS facilities for the period 1991 through 1993 are listed in Appendix F.

Table 3.8.3–1 presents the baseline ambient air concentration for criteria pollutants and other pollutants of concern at RFETS. As shown in the table, baseline concentrations are in compliance with applicable guidelines and regulations.

Noise. Major noise sources at RFETS include various facilities, equipment, and machines (for example, cooling systems, transformers, engines, pumps, boilers, steam vents, paging systems, construction and materials-handling equipment, and vehicles). No sound-level measurements have been made around RFETS to determine background sound levels. Most RFETS industrial facilities are at a sufficient distance from the site boundary to make noise levels at the boundary from these sources barely distinguishable from background noise.

The acoustic environment along the RFETS boundary and at nearby residences away from traffic noise is typical of a rural location or quiet suburban residential area, with DNL in the range of 35 to 52 dBA (EPA 1974a:B-4). Traffic is the primary source of noise at the site boundary and at nearby residences. Plant traffic contributes little to overall traffic noise. However, traffic noise is expected to dominate sound levels along major roads in the area. Except for the prohibition of nuisance noise, neither the State of Colorado nor its local governments have established environmental noise standards applicable to RFETS.

Table 3.8.3–1. Comparison of Baseline Ambient Air Concentrations With Most Stringent Applicable Regulations or Guidelines at Rocky Flats Environmental Technology Site, 1991-1994

Pollutant	Averaging Time	Most Stringent Regulations or Guidelines[a] (μg/m³)	Baseline Concentration[b] (μg/m³)
Criteria Pollutants			
Carbon monoxide	8-hour	10,000[c]	145
	1-hour	40,000[c]	534
Lead	Calendar Quarter	1.5[c]	[d]
	30-day	1.5[e]	[d]
Nitrogen dioxide	Annual	100[c]	4.14
Ozone	1-hour	160[e]	[f]
Particulate matter less than or equal to 10 microns in diameter	Annual	50[c]	0.235
	24-hour	150[c]	17.4
Sulfur dioxide	Annual	80[c]	0.295
	24-hour	365[c]	21.8
	3-hour	700[e]	64.6
Mandated by the State of Colorado			
Hydrogen sulfide	1-hour	142[e]	<0.01
Total suspended particulates	Annual	75[e]	0.284
	24-hour	150[e]	21.0
Hazardous and Other Toxic Compounds			
1,1,2-Trichloro-1,2,2 Trifluoroethane	Annual	[g]	0.01
Carbon tetrachloride	Annual	[g]	0.01
Dioctyl phthalate	Annual	[g]	<0.01
Methylene chloride	Annual	[g]	<0.01
Nitric acid	Annual	[g]	<0.01
Trichloroethane	Annual	[g]	<0.01

[a] The more stringent of the Federal and State standard is presented if both exist for the averaging time.
[b] Modeled concentration based on permit data.
[c] Federal and State standard.
[d] Data not available from the source document.
[e] State standard.
[f] Ozone, as a criteria pollutant, is not directly emitted or monitored by the site. See Section 4.1.3 for a discussion of ozone-related issues.
[g] No State standard for indicated averaging time.
Source: 40 CFR 50; CO DPHE 1994a; RFETS 1995a:1.

3.8.4 WATER RESOURCES

Surface Water. The main surface water features at RFETS are Walnut Creek, North Walnut Creek, South Walnut Creek, and Woman Creek (Figure 3.8.4–1). The streams at RFETS are considered part of the Big Dry Creek drainage basin, although Big Dry Creek is not directly affected by RFETS activities. Rock Creek flows through the northwestern portion of the site and is physically separate from the operational plant complex; as such, Rock Creek is unaffected by site activities. Rock Creek has been maintained in an undisturbed condition since 1952.

The RFETS lies on the divide between Walnut Creek and Woman Creek drainage basins. North Walnut Creek and South Walnut Creek drain the central and northern areas of RFETS, and Woman Creek drains the southern areas. The confluence of South and North Walnut Creeks forms Walnut Creek. Walnut Creek flows downstream from RFETS and empties into the Broomfield Diversion Ditch. The Broomfield Diversion Ditch routes water around the Great Western Reservoir, which is a public water supply, then into Big Dry Creek, and eventually into the South Platte River.

Woman Creek flows east across the southern portion of RFETS into Standley Lake, which provides irrigation storage and municipal water for surrounding communities. Woman Creek may also be diverted into Mower Reservoir which also flows into Standley Lake. Standley Lake flows into Big Dry Creek, which flows into the South Platte River.

All natural surface water flow on RFETS occurs in ephemeral channels that flow only as a result of precipitation, discharge of site effluents, surface seeps, or release of water from storage areas west of the site to supplement water supplies in the Great Western Reservoir or Standley Lake. On North Walnut Creek, South Walnut Creek, and Woman Creek, a series of unlined ponds serve to impound waters from the site. Along North Walnut Creek, the ponds are numbered A–1 through A–4; on South Walnut Creek, the ponds are numbered B–1 through B–5; and on Woman Creek, the ponds are numbered C–1 and C–2. Pond C–2 is off channel from Woman Creek and does not receive direct flow. Flow into Pond C–2 is from runoff into South Interception Ditch and then into Pond C–2.

Wastewater from industrial processes is treated at a treatment plant that is isolated from other sources and does not discharge to surface water features. Existing sanitary wastewater generation is estimated at approximately 150 million l/yr (39.6 million gal/yr). Sanitary wastewater is treated and discharged to Pond B–3. Stormwater runoff from the plant is conveyed in storm sewers that discharge to creeks on the undeveloped portion of the site. Discharges from Ponds A–3, A–4, B–3, B–5 and C–2 are monitored under the NPDES-permit program.

Terminal ponds (A–4, B–5, and C–2) are designed to capture the flow from a 100-year storm if maintained at less than 10 percent of capacity. However, RFETS has been unable to maintain the 10-percent capacity limit due to the treatment of large quantities of water and delays in receiving approval for certain discharges.

The primary source of flood potential at RFETS is from flash flooding in seasonal streams. Of these, Woman Creek and North and South Walnut Creek drain the part of the site occupied by plant facilities. A recent study evaluating flooding potential at RFETS indicated that even in the most extreme circumstances it is unlikely that flows on Woman Creek could pose a hazard to facilities. The stream is at least 24 m (79 ft) below the elevation of structures in proximity to the stream (LLNL 1988a:3-1). Because evidence suggested that Walnut Creek may be subject to excessive flows during periods of high rainfall and runoff, a probabilitic flood analysis was performed. The 500-year floodplain of Walnut Creek corresponds to an elevation of approximately 1,806 m (5,925 ft). The majority of RFETS facilities are located between elevations of 1,814 and 1,844 m (5,952 and 6,050 ft) mean sea level. Therefore, these facilities lie outside the 500-year floodplain.

The RFETS does not withdraw any water from streams on or near the site. All water for the plant is obtained from surface waters from the city of Denver via the South Boulder Diversion Canal from the South Boulder Creek and

Ralston Reservoir. The water supply contract with the city and county of Denver through the Denver Water Board is for an unguaranteed supply of up to 5.7 million l/day (1.5 million gal/day). The current average water consumption is approximately 485 million l/yr (128 million gal/yr). Raw water is stored in a 5.7 million l (1.5 million gal) storage pond west of the plant.

Surface Water Quality. The water from Woman Creek, North Walnut Creek, and South Walnut Creek flows into ponds that restrict offsite discharges and allow water testing and, if necessary, treatment to meet water quality standards. A treatment facility is located at Pond A–4. Water from Pond B–5 is transferred to Pond A–4. Treatment consists of filtration and carbon absorption to reduce potential radionuclides and organic chemical contaminants. With concurrence from the Colorado Department of Health, water is released from Pond A–4 to Walnut Creek, and from Pond C–2 to the Broomfield Diversion Ditch, or in an emergency, to Ponds A–4 or B–5.

Discharges from Ponds A–4 and B–5 enter Walnut Creek and are diverted around the Great Western Reservoir by the Broomfield Diversion Ditch. Water is discharged untreated from Pond C–2 through a 2,438 m (7,999 ft) pipeline into the Broomfield Diversion Ditch and around the Great Western Reservoir. The release of untreated discharge from Pond C–2 has been approved by EPA because sampling indicates that the discharge meets all Woman Creek standards except for gross beta. The gross beta standards for Walnut Creek, the eventual destination of the piped discharge are higher, and no standard is exceeded.

An unlined surface water control pond exists immediately downstream and downgradient of the landfill and current waste disposal operations at the eastern end of the landfill. The landfill is considered a hazardous waste management landfill due to past disposal of some materials that may now qualify as regulated hazardous wastes. The landfill pond routinely exceeds the RFETS standard for strontium and has exceeded standards for copper, iron, lithium, manganese, mercury, nickel, Pu, and zinc. The landfill pond does not discharge to natural surface waters.

Water quality monitoring results for Walnut Creek and Woman Creek are presented in Table 3.8.4–1. These results indicate that concentrations were less than the water quality criteria listed. No Notices of Violations were received by RFETS in 1993 for NPDES limitations.

Surface Water Rights and Permits. Surface water rights are not an issue at RFETS because RFETS facilities do not withdraw surface water for use. As previously mentioned, the water supply contract with the city and county of Denver is for an unguaranteed supply of up to 5.7 million l/day (1.5 million gal/day).

Groundwater. Two nonhydraulically connected groundwater systems are present at RFETS. The upper unit exists as an unconfined aquifer and the lower unit as a confined aquifer. The contact separating the two units is identified as the base of the weathered zone.

The unconfined aquifer at RFETS is primarily unconsolidated alluvial material. The average depth to the water table in the unconsolidated surficial deposits range from about 21 m (70 ft) at the western boundary of RFETS to less than 3 m (10 ft) in the industrial area. Seeps are common along stream drainage. Groundwater flow direction is generally toward the east. Recharge to the unconfined aquifer occurs from infiltration of precipitation and as seepage from ditches, creeks, and ponds. In addition, retention ponds along South Walnut and Woman Creeks probably recharge this unit.

In the confined aquifer, groundwater is in the sandstone lenses below most of the plant. Flow within the sandstones is assumed to be from west to east. In some places, the sandstones are in contact with the alluvium so that the unit is part of the unconfined system at those places. Recharge to the sandstones occurs where they are in direct contact with the alluvium and valley fill of the upper aquifer or by leakage through claystones in contact with alluvium. The sandstone units discharge along the South Platte River, about 47 km (29 mi) east of RFETS.

Table 3.8.4–1. Summary of Surface Water Quality Monitoring at Rocky Flats Environmental Technology Site, 1993

Parameter	Unit of Measure	Water Quality Criteria and Standards[a]	Existing Water Body Concentration	
			Average	Maximum
Receiving Water: Walnut Creek				
Alpha (gross)	pCi/l	11[b]	2.4	2.9
Americium-241	pCi/l	0.05[b]	0.001	0.013
Beryllium	mg/l	0.004[c]	<0.001	<0.001
Beta (gross)	pCi/l	19[b]	2.0	3.0
Copper	mg/l	1.0[d]	0.008	0.010
Lead	mg/l	0.015[c]	<0.002	<0.047
Plutonium-239/240	pCi/l	1.2[e]	0.002	0.024
Total dissolved solids	mg/l	500[d]	325	350
Tritium	pCi/l	500[b]	0	250
Uranium-233/234	pCi/l	10[b]	0.65	1.00
Uranium-238	pCi/l	10[b]	0.69	1.17
Receiving Water: Woman Creek				
Americium-241	pCi/l	0.05[b]	0.017	0.017
Beryllium	mg/l	0.004[c]	<0.001	<0.001
Copper	mg/l	1.0[d]	0.004	0.004
Lead	mg/l	0.015[c]	<0.050	<0.050
Plutonium-239/240	pCi/l	1.2[e]	0.010	0.010
Total dissolved solids	mg/l	500[d]	328	328
Tritium	pCi/l	500[b]	67	110
Uranium-233/234	pCi/l	5[b]	2.74	2.74
Uranium-235	pCi/l	5[b]	0.08	0.08
Uranium-238	pCi/l	5[b]	2.32	2.32

[a] For comparison purposes only, except for parameters that have Colorado State Water Quality Standards. [Text deleted.]
[b] Colorado State Water Quality Standards, specific for Walnut and Woman Creeks.
[c] National Primary Drinking Water Regulations (40 CFR 141).
[d] National Secondary Drinking Water Regulations (40 CFR 143).
[e] DOE DCG for water (DOE Order 5400.5). DCG values are based on a committed effective dose of 100 mrem per year; however, because the drinking water maximum contaminant level is based on 4 mrem per year, the number listed is 4 percent of the DCG.
Source: RFETS 1994a.

Groundwater Quality. Groundwater monitoring has been conducted at RFETS since 1960. By the end of 1994, about 300 wells were monitored for the purpose of determining groundwater quality and to determine the distribution of contaminant constituents in groundwater at RFETS. Groundwater quality in uncontaminated portions in surficial materials (alluvium, colluvium, valley fill, and weathered bedrock) is relatively good and can be classified as calcium bicarbonate water. The unweathered bedrock groundwater system can be distinguished from the surficial system by relatively higher sodium and sulfate content. Background groundwater quality for the upper and lower hydrostratigraphic units beneath RFETS is summarized in Table 3.8.4–2.

The unconfined aquifer contains both radiological and nonradiological contaminants. To date, the understanding of the hydrogeologic relationships indicate that there are no known bedrock pathways through which

Table 3.8.4–2. Groundwater Quality Monitoring at Rocky Flats Environmental Technology Site, 1994

Parameter	Unit of Measure	Water Quality Criteria and Standards[a]	Existing Conditions: Upper Hydrostatic Unit	Existing Conditions: Lower Hydrostatic Unit
Alpha (gross)	pCi/l	15[b]	8.354	3.127
Americium-241	pCi/l	1.2[c]	0.011	0.028
Beryllium	mg/l	0.004[b]	0.00222	0.00204
Beta (gross)	pCi/l	50[d]	4.892	3.234
Cadmium	mg/l	0.005[b]	0.00245	0.00240
Cesium-137	pCi/l	120[c]	0.420	0.217
Chloride	mg/l	250[e]	12.8	100.108
Copper	mg/l	1.0[e]	0.01085	0.00970
Lead	mg/l	0.015[b]	0.00855	0.00272
pH	pH Units	6.5-8.5[e]	7.14	7.85
Radium-226	pCi/l	5[b]	0.258	1.723
Strontium-89/90	pCi/l	800[c]/400[c]	0.338	0.473
Sulfate	mg/l	250[e]	86.230	123.943
Total dissolved solids	mg/l	500[e]	354.151	545.138
Tritium	pCi/l	80,000[c]	101.702	56.881
Uranium-233/234	pCi/l	20[c]	6.914	1.643
Uranium-235	pCi/l	24[c]	0.195	0.033
Uranium-238	pCi/l	24[c]	4.832	0.768

[a] For comparison purposes only.
[b] National Primary Drinking Water Regulations (40 CFR 141).
[c] DOE DCG for Water (DOE Order 5400.5). DCG values are based on a committed effective dose of 100 mrem per year; however, because the drinking water maximum contaminant level is based on 4 mrem per year, the number listed is 4 percent of the DCG.
[d] Proposed National Drinking Water Regulations; Radionuclides (56 FR 33050).
[e] National Secondary Drinking Water Regulations (40 CFR 143).
Source: RFETS 1995a:3.

groundwater contamination can directly leave RFETS and migrate into the confined aquifer system offsite (RFETS 1994a:123).

There are five principle areas where groundwater has been affected by plant activities at RFETS (Figure 3.8.4–2). The first plume is associated with the solar evaporation ponds, which were used to store radioactive/hazardous waste. The main contamination from this plume surrounds 207A and 207B ponds. Groundwater flow data across the solar evaporation ponds area diverges along two flow paths. One flow path is northeasterly toward North Walnut Creek and the other is southeasterly toward South Walnut Creek. Groundwater quality data from 1993 indicate that the solar ponds contributed nitrate/nitrite, sodium, TDSs, fluoride, bicarbonate, sulfate, dissolved radionuclides, several dissolved metals, and VOCs to the groundwater in surficial material and weathered bedrock immediately north, east, and southeast of the ponds (RFETS 1994a:130). The radionuclides include tritium, Pu-239, -240, Americium-241, and U-233,-234, -235, and -238.

The second plume, the 903 Pad, Mound, and Trench plume, is located in the southeastern-central portion of RFETS. The 903 Pad and Mound areas were historically used for storage and burial, respectively, of radioactively contaminated wastes. The plume located in the upper hydrostratigraphic unit is contaminated with

VOCs, inorganics, dissolved metals, and some radionuclides (RFETS 1994a:127). The plume does not lie beneath buildings that house DOE activities.

The third plume is associated with the present landfill and is located at the western end of an unnamed drainage channel which discharges to North Walnut Creek. [Text deleted.] The plume contains inorganic analytes, dissolved metals, dissolved radionuclides, and VOCs, as well as nitrate and nitrite above standard levels (RFETS 1994a:136). The plume does not lie beneath buildings that house DOE activities.

The fourth plume is the 881 Hillside plume, located in the south-central portion of RFETS in the shallow groundwater system. Based on the most recently completed Phase III remedial investigation, VOCs (that is, carbon tetrachloride, perchloroethylene, and trichloroethylene) pose the most public health risk (RFETS 1994a:127). This area was used for the storage of drums containing cleaning solvents from 1967 to 1972. The plume also contains elevated levels of total dissolved solids, metals (nickel, Sr, selenium, zinc, and copper), and uranium. The plume does not lie beneath any buildings housing DOE activities.

The fifth plume is associated with the Western Industrial Area, with primary contamination occurring in the western portion of the RFETS buffer zone. Within and adjacent to the Western Industrial Area, groundwater quality has been impacted by carbon tetrachloride, tetrachloroethene, and trichloroethene. This plume does not lie beneath buildings that house DOE activities.

Groundwater Availability, Use, and Rights. Currently, no groundwater is used for potable purposes by the facility. However, approximately 10.6 million l/yr (2.8 million gal/yr) of groundwater is withdrawn from the site as part of the environmental restoration program, for contaminant removal.

In general, the rights to groundwater resources in Colorado are unrelated to ownership of the land under which those groundwater resources are located. However, for the Denver Basin aquifers, which include the lower aquifers at the RFETS, the right to groundwater resources derives from land ownership as long as the water is not tributary to any surface water supplies.

3.8.5 GEOLOGY AND SOILS

Geology. The RFETS is located on the western edge of the Colorado Piedmont section of the Great Plains physiographic province. The site is located on the west flank of the Denver Basin, an extensive sedimentary basin bordered on the west by the base of the Colorado Front Range. The site is located on a geomorphic surface comprised of a gravel-capped pediment surface identified as the Rocky Flats alluvial surface.

The surficial geology at RFETS consists of Quaternary alluvial, colluvial, eolian, and landslide deposits that range in thickness from several centimeters to over 30.5 m (100 ft). The most important unit is the Rocky Flats Alluvium, which consists of poorly sorted deposits of sand, gravel, and cobbles in a clay matrix that thins from west to east across the site (RF DOE 1985a:21). The Arapahoe Formation (Cretaceous-age), which immediately underlies the Rocky Flats Alluvium at RFETS, is approximately 0 to 36.5 m (0 to 120 ft) thick and consists of fluvial claystones with interbedded lenticular sandstones and siltstones (RF DOE 1985a:20; RF EG&G 1994a:G-1,G-2).

The RFETS lies in Seismic Zone 1, indicating minor damage could occur as a result of earthquakes (Figure 3.2.5–1). Occasional earthquakes with MMI of V to VI occur in Colorado. No major faults cut the Arapahoe Formation or overlying alluvium in the vicinity of RFETS (RF DOE 1985a:20). The Livingston fault, located approximately 5 km (3 mi) to the west, and the Golden fault, located approximately 8 km (5 mi) to the south, are the mountain-front faults closest to the facility. Neither fault is recognized as a capable fault according to 10 CFR 100, Appendix A. No other capable faults are present in the immediate vicinity of RFETS. There are no known areas of active volcanism in the Denver Basin.

Landslides and other mass earth movements are present as shallow features where slopes are steep. Nearly all of the site, however, has slopes averaging only 2 percent. Slopes may be greater than 2 percent along the sides of washes.

Soils. The RFETS is underlain mainly by soils of the Denver-Kutch and Flatirons-Velscamp soil associations. Erosion potential of the Denver-Kutch soil is low to moderate and shrink-swell potential is moderate to high. The Flatirons-Velscamp soil does not pose an erosion hazard, and its shrink-swell potential is low to moderate.

3.8.6 BIOLOGICAL RESOURCES

Terrestrial Resources. The RFETS is located at an elevation of 1,829 m (6,000 ft) above sea level, at the approximate elevation where plains grassland vegetation meets lower montane forest (RF DOE 1980a:2-93). Plant facilities occupy about 6 percent of the total site area. Vegetative communities on RFETS have been divided into four basic types; those within the central portion of the site are shown on Figure 3.8.6–1. Plant communities include grassland, marshland, woodland, and shrubland. Grassland is the most common community onsite, with mesic and zeric grasslands being the predominant subtypes. Marshland occurs along several creeks that traverse the site. Woodlands and shrublands are not common communities on RFETS. Habitats that are considered important to wildlife (especially waterfowl and passerine birds) include riparian zones along creeks and trees on south facing slopes (RFP 1992b:3). A total of 362 species of vascular plants have been identified on the site (RF DOE 1991i:23).

It appears that vegetation is recovering from the grazing that occurred before Government acquisition of the land. Recent studies have indicated that plant succession has progressed since the 1970s. Most areas formerly mapped as annual weed communities now qualify as perennial grassland. Indicator species for perennial grassland such as western wheatgrass and Canada bluegrass have increased in abundance and now dominate over much of the site (RF DOE 1991i:4).

Animals identified on the RFETS include 4 amphibian, 8 reptile, 167 bird, and 36 mammal species (RF DOE 1995a:2). Common animals of the site include the common bullsnake, prairie rattlesnake, western meadowlark, mourning dove, coyote, and mule deer (RF DOE 1991i:4,5,23,24). A variety of game animals occur on the site; however, hunting is not permitted. Numerous raptors, such as the red-tailed hawk and rough-legged hawk, and carnivores, such as the coyote and long-tailed weasel, are found on RFETS. Migratory birds and their nests and eggs are protected by the *Migratory Bird Treaty Act*. Eagles are similarly protected by the *Bald and Golden Eagle Protection Act*.

Wetlands. Rocky Flats Environmental Technology Site contains a variety of wetlands including intermittent streams, ditches, ponds, and hillside seeps. Most wetlands that occur onsite are found along ephemeral streams and are classified on NWI maps as palustrine. There are several manmade wetlands on the site including vegetated sections of ditches, such as the South Interceptor Ditch, the A, B, and C-series ponds, and the landfill pond. Wetlands also occur at various locations around the site that are fed by drains and stormwater from paved areas and other surface runoff (RFP 1991c:4). Numerous seeps are scattered on the hillsides of the site. Vegetation typical of wetlands at RFETS includes sandbar willow, American watercress, plains cottonwood, broad-leaf cattail, and bulrush. In total there are about 43 ha (107 acres) of aerial wetlands and 25.9 km (16.1 mi) of narrow wetlands along streambeds within RFETS (RF DOE 1990b:18,19,22).

Aquatic Resources. Aquatic habitat on RFETS consists of ephemeral streams, ditches, ponds, and springs. Four streams flow within the site boundaries; North Walnut Creek, South Walnut Creek, Woman Creek, and Rock Creek (Figure 3.8.4-1). Each of these streams supports a series of on-channel retention reservoirs or ponds which collect surface water runoff and wastewater. North and South Walnut Creek, which are located in the northeast portion of the site, flow eastward offsite and into Great Western Reservoir. Fathead minnows are found in these streams. There are three holding ponds along North Walnut Creek and four ponds along South Walnut Creek. These ponds support crayfish and various other macroinvertebrates; fathead minnows are found in at least one of the ponds (RF DOE 1980a:2-96).

Woman Creek, which is located in the southern portion of the site, flows eastward offsite and into Standley Lake. Seven species of fish have been identified in Woman Creek and include several minnows, largemouth bass, green sunfish, and the white sucker (RF DOE 1991b:4). Redside dace and bluegill occur in holding ponds located along Woman Creek (RF DOE 1980a:2-97).

Rock Creek is located in the northwest portion of the site and is unlikely to support a large number of fish. However, Lindsay Pond, located on Rock Creek, does provide habitat for redside dace and largemouth bass (RF DOE 1980a:2-96).

Ditches located on RFETS convey stormwater runoff to holding ponds. These ditches do not support any fish populations. There are several permanent and temporary ponds located throughout the site, and a number of springs are found in the southwest portion of the site. Information is not available on the aquatic organisms found in these habitats (RFP 1992b:4).

Threatened and Endangered Species. The 35 federally and State-listed threatened, endangered, and other special-status species that may be found on or in the vicinity of the RFETS area are listed in Table 3.8.6–1. Twelve of these species have been observed on or in close proximity to the site. Potential suitable habitat for the remaining 23 species exists on RFETS. No critical habitat for threatened or endangered species, as defined in the ESA (50 CFR 17.11; 50 CFR 17.12), exists on RFETS.

Table 3.8.6–1. Federally and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found on or in the Vicinity of Rocky Flats Environmental Technology Site

Common Name	Scientific Name	Status[a]	
		Federal	**State**
Mammals			
[Text deleted.]			
Preble's meadow jumping mouse[b]	*Zapus hudsonius preblei*	NL	SC
[Text deleted.]			
Spotted bat	*Euderma maculatum*	NL	U
Swift fox	*Vulpes velox*	C	U
Birds			
American peregrine falcon[b,c]	*Falco peregrinus anatum*	E	T
American white pelican[b]	*Pelecanus erythrorhynchos*	NL	SC
Arctic peregrine falcon[c]	*Falco peregrinus tundrius*	E (S/A)	T
[Text deleted.]			
Bald eagle[b,c]	*Haliaeetus leucocephalus*	T	T
Barrow's goldeneye	*Bucephala islandica*	NL	SC
[Text deleted.]			
Black-throated gray warbler[b]	*Dendroica nigrescens*	NL	SC
Blue grosbeak[b]	*Guiraca caerulea*	NL	SC
Ferruginous hawk[b]	*Buteo regalis*	NL	SC
Greater sandhill crane[b]	*Grus canadensis tibida*	NL	T
Least tern[c]	*Sterna antillarum*	E	E
[Text deleted.]			
Long-billed curlew[b]	*Numenius americanus*	NL	SC
Mountain plover	*Charadrius montanus*	C	SC
[Text deleted.]			
Piping plover[c]	*Charadrius melodus*	T	T
Plains sharp-tailed grouse	*Tympanuchus phasianellus jamesi*	NL	E
Southwestern willow flycatcher	*Empidonax traillii extimus*	E	NL
Western burrowing owl[b]	*Athene cunicularia hypugea*	NL	U

Table 3.8.6–1. Federally and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found on or in the Vicinity of Rocky Flats Environmental Technology Site—Continued

Common Name	Scientific Name	Status[a]	
		Federal	**State**
Western snowy plover	*Charadrius alexandrinus nivosus*	NL	SC
White-faced ibis	*Plegadis chihi*	NL	U
Whooping crane[c]	*Grus americana*	E	E
[Text deleted.]			
Fish			
Common shiner	*Notropis comutus*	NL	SC
[Text deleted.]			
Stonecat	*Noturus flavus*	NL	SC
Plants			
Adder's mouth orchid	*Malaxis brachypoda*	NL	SC
Bell's twinpod	*Physaria bellii*	NL	SC
Black spleenwort	*Aspelenium adiantum-nigrum*	NL	SC
Colorado butterfly plant	*Guara neomexicana coloradensis*	C	SC
Forktip three-awn[b]	*Aristida basiramea*	NL	SC
Gay-feather	*Liatris ligulistylus*	NL	SC
Sedge[b]	*Carex oreocharis*	NL	SC
Toothcup	*Rotala ramosior*	NL	SC
Tulip gentian	*Eustoma grandiflora*	NL	SC
Ute ladies'-tresses	*Spiranthes diluvialis*	T	SC
Yellow stargrass	*Hypoxis hirsuta*	NL	SC

[a] Status codes: C=Federal candidate; E=endangered; NL=not listed; S/A=protected under the similarity of appearance provision of the *Endangered Species Act*; SC=State species of concern; T=threatened; U=State undetermined species.
[b] Species observed on RFETS.
[c] USFWS Recovery Plan exists for this species.
Source: 50 CFR 17.11; 50 CFR 17.12; CO NHP 1994a; RF DOE 1995d.

Three federally listed threatened or endangered species (the bald eagle, peregrine falcon [both subspecies], and Ute ladies'-tresses) occur or are likely to occur on the RFETS site. Bald eagles have been observed flying over and occasionally foraging on RFETS and are known to roost at Standley Lake and Great Western Reservoir, approximately 1.8 km (1.1 mi) and less than 0.5 km (0.3 mi), respectively, from the site. Peregrine falcons have been observed flying over and hunting onsite. Two historical nest sites are within 16 km (10 mi) of the site. Ute ladies'-tresses are known to occur approximately 12.9 km (8 mi) north of the site in Boulder County (RF DOE 1995a:2,3). Suitable habitat exists on RFETS for this species, but no specimens were found during site surveys. Although the complex of prairie dog towns on the site provides suitable habitat for the endangered black-footed ferret, occurrence of the ferret is highly unlikely (RF DOE 1991j:5), and the area has been cleared of the requirement for verifying surveys.

[Text deleted.] The State-listed greater sandhill crane and several other special status species have been observed on RFETS. Continued site surveys may determine the occurrence of other special status species listed in Table 3.8.6–1.