Office of
Fissile Materials Disposition

United States Department of Energy

Surplus Plutonium Disposition Final Environmental Impact Statement

Volume I - Part A

November 1999

For Further Information Contact:
U.S. Department of Energy
Office of Fissile Materials Disposition, P.O. Box 23786, Washington, DC 20026-3786

DOE/EIS-0283

Surplus Plutonium Disposition Final Environmental Impact Statement

Volume I - Part A

United States Department of Energy
Office of Fissile Materials Disposition

November 1999

Cover Sheet

Responsible Agency: United States Department of Energy (DOE)

Title: *Surplus Plutonium Disposition Final Environmental Impact Statement* (SPD EIS) (DOE/EIS-0283)

Locations of Candidate Sites: California, Idaho, New Mexico, North Carolina, South Carolina, Tennessee, Texas, Virginia, and Washington

Contacts:

For further information on the SPD Final EIS contact:

Mr. G. Bert Stevenson, NEPA Compliance Officer
Office of Fissile Materials Disposition
U.S. Department of Energy
P.O. Box 23786
Washington, DC 20026-3786
Voice: (202) 586–5368

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

Ms. Carol Borgstrom, Director
Office of NEPA Policy and Assistance
Office of Environment, Safety and Health
U.S. Department of Energy
1000 Independence Ave., SW
Washington, DC 20585
Voice: (202) 586–4600 or (800) 472–2756

Abstract: On May 22, 1997, DOE published a Notice of Intent in the Federal Register (62 Federal Register 28009) announcing its decision to prepare an environmental impact statement (EIS) that would tier from the analysis and decisions reached in connection with the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic EIS*. At that time, the U.S. Environmental Protection Agency decided to be a cooperating agency. The *Surplus Plutonium Disposition Draft Environmental Impact Statement* (SPD Draft EIS) (DOE/EIS-0283-D) was prepared in accordance with NEPA and issued in July 1998. It identified the potential environmental impacts of reasonable alternatives for the proposed siting, construction, and operation of three facilities for the disposition of up to 50 metric tons (55 tons) of surplus plutonium, as well as a No Action Alternative. These three facilities would accomplish pit disassembly and conversion, plutonium conversion and immobilization, and mixed oxide (MOX) fuel fabrication.

For the alternatives that included MOX fuel fabrication, the SPD Draft EIS described the potential environmental impacts of using from three to eight commercial nuclear reactors to irradiate MOX fuel. The potential impacts were based on a generic reactor analysis that used actual reactor data and a range of potential site conditions. In May 1998, DOE initiated a procurement process to obtain MOX fuel fabrication and reactor irradiation services. In March 1999, DOE awarded a contract to Duke Engineering & Services, COGEMA Inc., and Stone & Webster (known as DCS) to provide the requested services. A *Supplement to the SPD Draft EIS* was issued in April 1999, which analyzed the potential environmental impacts of using MOX fuel in six specific reactors named in the DCS proposal. Those reactors are Catawba Nuclear Station Units 1 and 2 in South Carolina, McGuire Nuclear Station Units 1 and 2 in North Carolina, and North Anna Power Station Units 1 and 2 in Virginia.

DOE has identified the hybrid approach as its Preferred Alternative for the disposition of surplus plutonium. This approach allows for the immobilization of 17 metric tons (19 tons) of surplus plutonium and the use of 33 metric tons (36 tons) as MOX fuel. DOE has identified the Savannah River Site near Aiken, South Carolina, as the preferred site for all three disposition facilities (Alternative 3). DOE has also identified Los Alamos National

Laboratory in New Mexico as the preferred site for lead assembly fabrication, and Oak Ridge National Laboratory in Tennessee as the preferred site for postirradiation examination of lead assemblies.

Public Involvement: In preparing the SPD Final EIS, DOE considered comments on the SPD Draft EIS and the *Supplement to the SPD Draft EIS* received via mail, fax, and email, and comments recorded by phone and transcribed from videotapes. In addition, comments were captured by notetakers during interactive public meetings held on the SPD Draft EIS in August 1998 in Amarillo, Texas; Idaho Falls, Idaho; North Augusta, South Carolina; Portland, Oregon; and Richland, Washington, as well as during a public meeting on the *Supplement to the SPD Draft EIS* held in June 1999 in Washington, D.C. Comments received and DOE's responses to these comments are found in Volume III, the Comment Response Document, of the SPD Final EIS. Information on the surplus plutonium disposition program can be obtained by visiting the Office of Fissile Materials Disposition Web site at http://www.doe-md.com.

Table of Contents

List of Figures

Volume I - Part A

List of Tables

Volume I - Part A

List of Acronyms

AEA	Atomic Energy Act of 1954
AECL	Atomic Energy of Canada Limited
AED	aerodynamic equivalent diameter
AIRFA	American Indian Religious Freedom Act
ALARA	as low as is reasonably achievable
AMWTP	Advanced Mixed Waste Treatment Project
ANL–W	Argonne National Laboratory–West
APSF	Actinide Packaging and Storage Facility
AQCR	Air Quality Control Region
ARF	airborne release fraction
ARIES	Advanced Recovery Integrated Extraction System
AVLIS	Atomic Vapor Laser Isotope Separation
BEA	Bureau of Economic Analysis
BEIR V	Report V of the Committee on the Biological Effects of Ionizing Radiations
BIO	Basis for Interim Operation
BLM	Bureau of Land Management
BNFL	British Nuclear Fuels
BWR	boiling water reactor
CAA	Clean Air Act
CAB	Citizens Advisory Board
CANDU	Canadian Deuterium Uranium (reactors)
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFA	Central Facilities Area
CFR	Code of Federal Regulations
CPP	Chemical Processing Plant
CWA	Clean Water Act of 1972, 1987
D&D	decontamination and decommissioning
DBA	design basis accident
DCS	Duke Engineering & Services, COGEMA Inc., and Stone & Webster
DNFSB	Defense Nuclear Facilities Safety Board
DOC	U.S. Department of Commerce
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOL	U.S. Department of Labor
DOT	U.S. Department of Transportation
DR	damage ratio
DU PEIS	*Final Programmatic Environmental Impact Statement for Alternative Strategies for Long-Term Management and Use of Depleted Uranium Hexafluoride*
DWPF	Defense Waste Processing Facility
EA	environmental assessment
EBR	Experimental Breeder Reactor (I or II)
EIS	environmental impact statement
EPA	Environmental Protection Agency

ES&H	environment, safety, and health
ESTEEM	Education in Science, Technology, Energy, Engineering, and Math
ETB	Engineering Test Bay
ETTP	East Tennessee Technology Park
FAA	Federal Aviation Administration
FDP	fluorinel dissolution process
FEMA	Federal Emergency Management Agency
FFCA	Federal Facility Compliance Agreement
FFF	Uranium Fuel Fabrication Facility
FFTF	Fast Flux Test Facility
FI	field investigation
FM	Farm-to-Market (road)
FMF	Fuel Manufacturing Facility
FMEA	failure modes and effects analysis
FMEF	Fuels and Materials Examination Facility
FONSI	finding of no significant impact
FPF	Fuel Processing Facility
FPPA	Farmland Protection Policy Act
FR	Federal Register
GAO	General Accounting Office
GDP	gaseous diffusion plant
GE	General Electric Company
GENII	Generation II, Hanford environmental radiation dosimetry software system
GPS	global positioning satellite
HE	high explosive
HEPA	high-efficiency particulate air (filter)
HEU	highly enriched uranium
HFEF	Hot Fuel Examination Facility
HHS	Department of Health and Human Services
HIGHWAY	(computer code for distances and populations along U.S. highways)
HLW	high-level waste
HLWVF	high-level-waste vitrification facility
HMIS	Hazardous Materials Information System
HWTPF	Hazardous Waste Treatment and Processing Facility
HYDOX	hydride oxidation
IAEA	International Atomic Energy Agency
ICPP	Idaho Chemical Processing Plant
ICRP	International Commission on Radiological Protection
ID DHW	Idaho Department of Health and Welfare
INEEL	Idaho National Engineering and Environmental Laboratory
INRAD	Intrinsic Radiation
INTEC	Idaho Nuclear Technology and Engineering Center
IPE	Individual Plant Examination
ISC	Industrial Source Complex Model
ISC3	Industrial Source Complex Model, Version 3
ISCST3	Industrial Source Complex Model, Short-Term, Version 3
ISLOCA	interfacing systems loss-of-coolant accident
ITP	In-Tank Precipitation Process

LANL	Los Alamos National Laboratory
LCF	latent cancer fatality
LDR	Land Disposal Restrictions
LEU	low-enriched uranium
LLNL	Lawrence Livermore National Laboratory
LLW	low-level waste
LOCA	loss-of-coolant accident
LPF	leak path factor
LWR	light water reactor
M&H	Mason & Hanger Corporation
MACCS2	Melcor Accident Consequence Code System (computer code)
MAR	material at risk
MD	Office of Fissile Materials Disposition
MEI	maximally exposed individual
MIMAS	Micronized Master
MMI	Modified Mercalli Intensity
MOX	mixed oxide
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NAS	National Academy of Science
NCRP	National Council on Radiation Protection and Measurements
NDA	nondestructive analysis
NEPA	National Environmental Policy Act of 1969
NESHAPs	National Emissions Standards for Hazardous Air Pollutants
NIOSH	National Institute of Occupational Safety and Health
NOA	Notice of Availability
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPH	natural phenomena hazard
NPS	National Park Service
NRC	U.S. Nuclear Regulatory Commission
NRU	National Research Universal
NTS	Nevada Test Site
NWCF	New Waste Calcining Facility
NWPA	Nuclear Waste Policy Act
NWS	National Weather Service
ORIGEN	ORNL Isotope Generation and Depletion Code
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OSHA	Occupational Safety and Health Administration
PBF	Power Burst Facility
PEIS	programmatic environmental impact statement
PFP	Plutonium Finishing Plant
PIE	postirradiation examination
$PM_{2.5}$	particulate matter with an aerodynamic diameter less than or equal to 2.5 microns
PM_{10}	particulate matter with an aerodynamic diameter less than or equal to 10 microns
PNNL	Pacific Northwest National Laboratory
PRA	probabilistic risk assessment
PSD	prevention of significant deterioration
PUREX	Plutonium-Uranium Extraction (Facility)
PWR	pressurized water reactor
R&D	research and development

RADTRAN 4	(computer code: risks and consequences of radiological materials transport)
RANT	Radioactive Assay and Nondestructive Test
RAMROD	Radioactive Materials Research, Operations and Demonstration
RCRA	Resource Conservation and Recovery Act, as amended
REA	regional economic area
RF	respirable fraction
RfC	reference concentration
RfD	reference dose
RFETS	Rocky Flats Environmental Technology Site
RFP	Request for Proposal
RIA	Reactivity Insertion Accidents
RIMS II	Regional Input-Output Modeling System II (computer code)
RISKIND	(computer code: risks and consequences of radiological materials transport)
ROD	Record of Decision
ROI	region of influence
RMF	Radiation Measurements Facility
RWMC	Radioactive Waste Management Complex
S/A	Similarity of Appearance (provision of Endangered Species Act)
SAR	safety analysis report
SARA	Superfund Amendments and Reauthorization Act of 1986
SCDHEC	South Carolina Department of Health and Environmental Control
SCE&G	South Carolina Electric & Gas Company
SCSHPO	South Carolina State Historic Preservation Officer
SDWA	Safe Drinking Water Act, as amended
SEIS	supplemental environmental impact statement
SHPO	State Historic Preservation Officer
SI	sealed insert
SMC	Specific Manufacturing Complex
SNF	spent nuclear fuel
SNM	special nuclear material
SPD	surplus plutonium disposition
SPD EIS	*Surplus Plutonium Disposition Environmental Impact Statement*
SPERT	Special Power Excursion Reactor Test
SRS	Savannah River Site
SSM PEIS	*Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management*
SST/SGT	safe, secure trailer/SafeGuards Transport
SWMU	solid waste management unit
SWP 1	Service Waste Percolation Pond 1
TA	Technical Area
TCE	trichloroethylene
TNRCC	Texas Natural Resource Conservation Commission
TPBAR-LTA	tritium-producing burnable absorber rod lead test assembly
TRA	technical risk assessment
TRANSCOM	transportation tracking and communications system
TRU	transuranic
TRUPACT	TRU waste package transporter
TSCA	Toxic Substances Control Act
TSP	total suspended particulates

TVA	Tennessee Valley Authority
TWRS	tank waste remediation system
TWRS EIS	*Tank Waste Remediation System Final Environmental Impact Statement*
UC	Regents of the University of California
UFSAR	updated final safety analysis report
USACE	U.S. Army Corps of Engineers
USC	United States Code
USEC	United States Enrichment Corporation
USFWS	U.S. Fish and Wildlife Service
UV	ultraviolet
VOC	volatile organic compounds
VORTAC	very high frequency omnidirectional range/tactical air navigation (facility)
VRM	Visual Resource Management
WAG 3	Waste Area Grouping 3
WERF	Waste Experimental Reduction Facility
WIPP	Waste Isolation Pilot Plant
WM PEIS	*Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste*
WNP–1	Washington Nuclear Plant–1
WNP–2	Washington Nuclear Plant–2
WPPSS	Washington Public Power Supply System
WROC	Waste Reduction Operations Complex
WSRC	Westinghouse Savannah River Company
ZPPR	Zero Power Physics Reactor

Chemicals and Units of Measure

°C	degrees Celsius (Centigrade)
°F	degrees Fahrenheit
μCi	microcurie
μg	microgram
μm	micrometer (micron)
46°26'07"	46 degrees, 26 minutes, 7 seconds
Ci	curie
cm	centimeter
CO	carbon monoxide
CO_2	carbon dioxide
dB	decibel
dBA	decibel, A-weighted
DUF_6	depleted uranium hexafluoride
eH	oxidation reduction potential
ft	foot
ft^2	square foot
ft^3	cubic foot
g	gram
g	gravitational acceleration
gal	gallon
GWD	gigawatt days (per ton)
ha	hectare
hr	hour (in compound units)
in	inch
kg	kilogram
km	kilometer
km^2	square kilometers
kV	kilovolt
l	liter
lb	pound
m	meter
m^2	square meter
m^3	cubic meter
mg	milligram
mi	mile
min	minute
mph	miles per hour
mrem	millirem
MTHM	metric tons of heavy metal
MVA	megavolt-ampere
MW	megawatt
MWe	megawatt electric
MWh	megawatt-hour
N_2	nitrogen
nCi	nanocurie
NO_2	nitrogen dioxide
pCi	picocurie
pcm/F	percent mille/Farenheit
pH	hydrogen ion concentration
$PM_{2.5}$	particulate matter less than or equal to 2.5 μm in diameter
PM_{10}	particulate matter less than or equal to 10 μm in diameter
ppm	parts per million
PuO_2	plutonium dioxide
rad	radiation absorbed dose
rem	roentgen equivalent man
s	second
SO_2	sulfur dioxide
t	metric ton
ton	short ton
UF_6	uranium hexafluoride
UO_2	uranium dioxide
yd	yard
yd^3	cubic yard
yr	year (in compound units)
wt %	weight percent

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 BACKGROUND

In December 1996, the U.S. Department of Energy (DOE) published the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (*Storage and Disposition PEIS*) (DOE 1996a). That PEIS analyzes the potential environmental consequences of alternative strategies for the long-term storage of weapons-usable plutonium and highly enriched uranium (HEU) and the disposition of weapons-usable plutonium that has been or may be declared surplus to national security needs.[1] The Record of Decision (ROD) for the *Storage and Disposition PEIS*, issued on January 14, 1997 (DOE 1997a), outlines DOE's decision to pursue a hybrid approach to plutonium disposition that would make surplus weapons-usable plutonium inaccessible and unattractive for weapons use. DOE's disposition strategy, consistent with the Preferred Alternative analyzed in the *Storage and Disposition PEIS*, allows for both the immobilization of some (and potentially all) of the surplus plutonium and use of some of the surplus plutonium as mixed oxide (MOX) fuel in existing domestic, commercial reactors. The disposition of surplus plutonium would also involve disposal of both the immobilized plutonium and the MOX fuel (as spent fuel) in a potential geologic repository.[2,3]

On May 22, 1997, DOE published a Notice of Intent (NOI) in the Federal Register (FR) (DOE 1997b) announcing its decision to prepare an environmental impact statement (EIS) that would tier from the analysis and decisions reached in connection with the *Storage and Disposition PEIS*. This EIS, the *Surplus Plutonium Disposition Environmental Impact Statement* (SPD EIS), addresses the extent to which each of the two plutonium disposition approaches (immobilization and MOX) would be implemented and analyzes candidate sites for plutonium disposition facilities and activities (i.e., lead assembly fabrication and postirradiation examination),[4] as well as alternative technologies for immobilization. In July 1998, DOE issued the SPD Draft EIS. That draft included a description of the potential environmental impacts of using from three to eight commercial nuclear reactors to irradiate MOX fuel. The potential impacts were based on a generic reactor analysis. In March 1999, DOE awarded a contract for MOX fuel fabrication and irradiation services.[5] After this award, DOE issued a *Supplement to the SPD Draft EIS (Supplement)* (April 1999) that describes the potential environmental impacts of using MOX fuel at three proposed reactor sites and provides updated information on the proposed disposition program. These updates and site-specific analyses have been incorporated in this SPD Final EIS.

---

[1] DOE addresses the disposition of surplus HEU in a separate environmental impact statement, the *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement* (DOE 1996b) issued in June 1996, with the ROD (DOE 1996c) issued in August 1996.

[2] The U.S. Nuclear Regulatory Commission (NRC) has reviewed DOE's plans to place immobilized material into the potential geologic repository and has agreed that with adequate canister and package design features, the immobilized plutonium waste forms can be acceptable for disposal in the repository (Paperiello 1999).

[3] Sidebars are used throughout this SPD Final EIS to indicate where changes were made since the SPD Draft EIS and *Supplement* were issued. Section 1.7.4 discusses these changes.

[4] This SPD EIS also analyzes a No Action Alternative, i.e., the possibility of disposition not occurring and instead continued storage of surplus plutonium in accordance with the *Storage and Disposition PEIS* ROD.

[5] Limited activities may be conducted under this contract, including non-site-specific work associated with the development of the initial design for the MOX fuel fabrication facility and plans (paper studies) for outreach, long lead-time procurements, regulatory management, facility quality assurance, safeguards, security, fuel qualification, and deactivation. Under the contract options, no substantive design work or construction on the proposed MOX facility would begin before a SPD EIS ROD is issued, and any such work would depend on decisions in the ROD.

This SPD EIS analyzes a nominal 50 metric tons (t) (55 tons) of surplus weapons-usable plutonium, which is primarily in the form of pits (the core element of a nuclear weapon's fission component), metal, and oxides.[6] In addition to 38.2 t (42 tons) of weapons-grade plutonium already declared by the President as excess to national security needs, the material analyzed includes weapons-grade plutonium that may be declared surplus in the future, as well as weapons-usable, reactor-grade plutonium that is surplus to the programmatic and national defense needs of DOE. As depicted in Figure 1–1, there are seven locations of surplus plutonium within the DOE complex: the Hanford Site (Hanford) near Richland, Washington; Idaho National Engineering and Environmental Laboratory (INEEL) near Idaho Falls, Idaho; Lawrence Livermore National Laboratory in Livermore (LLNL), California;[7] Los Alamos National Laboratory (LANL) near Los Alamos, New Mexico; the Pantex Plant (Pantex) near Amarillo, Texas; the Rocky Flats Environmental Technology Site (RFETS) near Golden, Colorado; and the Savannah River Site (SRS) near Aiken, South Carolina.

Figure 1–1. Locations of Surplus Plutonium

Under the hybrid alternatives, about 34 percent of the surplus plutonium analyzed in this SPD EIS is not suitable for fabrication into MOX fuel due to the complexity, timing, and cost that would be involved in purifying the materials. The *Storage and Disposition PEIS* ROD determined that DOE would immobilize at least 8 t (9 tons)

[6] Some materials are already in a final disposition form (i.e., irradiated fuel) and will not require further action before disposal. These materials, therefore, are not included in the 50 t (55 tons) analyzed in this SPD EIS.

[7] Some of the surplus plutonium originally stored at RFETS was shipped to LLNL, where special handling and disassembly processes occurred. The receipt and disassembly of these materials and future processing work will result in the recovery of approximately 1.7 t (1.9 tons) of surplus plutonium at LLNL.

of the current surplus plutonium. Since issuance of the ROD, further consideration has indicated that 17 t (19 tons) of the surplus plutonium is not suitable for use in MOX fuel and should be immobilized. Therefore, fabricating all 50 t (55 tons) of surplus plutonium into MOX fuel is not a reasonable alternative and is not analyzed. This SPD EIS does, however, analyze the immobilization of all the surplus plutonium. (See Section 2.3.2.1 for a discussion on the amounts of materials subject to disposition.) Given the variability in purity of the surplus plutonium to be dispositioned, some of the plutonium currently considered for MOX fabrication may also need to be immobilized. The incremental impacts that would be associated with a small shift in materials throughput are discussed in Section 4.30.

In the *Storage and Disposition PEIS* ROD, DOE retained the option to use some of the surplus plutonium as MOX fuel in Canadian Deuterium Uranium (CANDU) reactors, which would have been undertaken only in the event that a multilateral agreement were negotiated among Russia, Canada, and the United States. Since the SPD Draft EIS was issued, DOE determined that adequate reactor capacity is available in the United States to disposition that portion of the U.S. surplus plutonium suitable for MOX fuel and, therefore, while still reserving the CANDU option, DOE is no longer actively pursuing it. However, DOE, in cooperation with Canada and Russia, proposes to participate in a test and demonstration program using U.S. and Russian MOX fuel in a Canadian test reactor.[8] If Russia and Canada agree to disposition Russian surplus plutonium in CANDU reactors in order to augment Russia's disposition capability, shipments of the Russian MOX fuel would take place directly between Russia and Canada.

1.2 PURPOSE OF AND NEED FOR THE PROPOSED ACTION

The purpose of and need for the proposed action is to reduce the threat of nuclear weapons proliferation worldwide by conducting disposition of surplus plutonium in the United States in an environmentally safe and timely manner. Comprehensive disposition actions are needed to ensure that surplus plutonium is converted to proliferation-resistant forms. In September 1993, President Clinton issued the *Nonproliferation and Export Control Policy* (White House 1993) in response to the growing threat of nuclear proliferation. Further, in January 1994, President Clinton and Russia's President Yeltsin issued a *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* (White House 1994). In accordance with these policies, the focus of the U.S. nonproliferation efforts includes ensuring the safe, secure, long-term storage and disposition of surplus weapons-usable fissile plutonium. Following publication of the SPD Draft EIS, the United States and Russia signed a 5-year agreement to provide the scientific and technical basis for decisions concerning how surplus plutonium will be managed and a statement of principles with the intention of removing approximately 50 t (55 tons) of plutonium from each country's stockpile (see Appendix A). The disposition activities proposed in this SPD EIS will enhance U.S. credibility and flexibility in negotiations on bilateral and multilateral reductions of surplus weapons-usable fissile materials inventories. [Text deleted.] The United States will retain the option to begin certain disposition activities, when appropriate, in order to encourage the Russians and set an international example.

This SPD EIS addresses both the immobilization and MOX approaches to surplus plutonium disposition, which include siting, construction, operation, and ultimate decontamination and decommissioning (D&D) of three types of facilities at one or two of four candidate DOE sites:

[8] A separate environmental review, the *Environmental Assessment for the Parallex Project Fuel Manufacture and Shipment* (DOE 1999a; Finding of No Significant Impact [FONSI], August 13, 1999), analyzes the fabrication and proposed shipment of MOX fuel rods for research and development activities involving the use of limited amounts of U.S. MOX fuel in a Canadian test reactor. The FONSI was announced in a press release on September 2, 1999, and made available to the public.

- A facility for disassembling pits (a weapons component) and converting the recovered plutonium, as well as plutonium metal from other sources, into plutonium dioxide suitable for disposition. This facility, the pit disassembly and conversion facility, is referred to in this document as the *pit conversion facility*. Candidate sites for this facility are Hanford, INEEL, Pantex, and SRS.

- A facility for immobilizing surplus plutonium for eventual disposal in a geologic repository pursuant to the Nuclear Waste Policy Act (NWPA), the plutonium conversion and immobilization facility, is referred to as the *immobilization facility*. This facility would include a collocated capability for converting nonpit plutonium materials into plutonium dioxide suitable for immobilization. The immobilization facility would be located at either Hanford or SRS. DOE identified SRS as the preferred site for an immobilization facility in the NOI to prepare the SPD EIS, which was issued in May 1997. Technologies for immobilization are also discussed in this SPD EIS.

- A facility for fabricating plutonium dioxide into MOX fuel, the MOX fuel fabrication facility, is referred to as the *MOX facility*. Candidate sites for this facility are Hanford, INEEL, Pantex, and SRS. Also included in this SPD EIS is a separate analysis of MOX lead assembly[9] activities at five candidate DOE sites: Argonne National Laboratory–West (ANL–W) at INEEL; Hanford; LLNL; LANL; and SRS. DOE would fabricate a limited number of MOX fuel assemblies, referred to as lead assemblies, for testing in a reactor before commencing fuel irradiation under the proposed MOX fuel program. Postirradiation examination activities at two sites, ANL–W and Oak Ridge National Laboratory (ORNL) in Oak Ridge, Tennessee, are also analyzed in this SPD EIS.

This SPD EIS also analyzes a No Action Alternative, as required by the National Environmental Policy Act (NEPA). In the No Action Alternative, surplus weapons-usable plutonium in storage at various DOE sites would remain at those locations. The vast majority of pits would continue to be stored at Pantex, and the remaining plutonium in various forms would continue to be stored at Hanford, INEEL, LLNL, LANL, RFETS, and SRS.[10]

1.3 DECISIONS TO BE MADE

DOE will base the following decisions on the analytical results of this SPD EIS and other cost, schedule, and nonproliferation considerations:

- Whether to construct and operate a pit conversion facility, and if so, where.

- Whether to construct and operate an immobilization facility, and if so, where (including selection of a technology for immobilization and the amount of plutonium to be immobilized).

- Whether to construct and operate a MOX facility, and if so, where (including separate selection of a site for fabrication of lead assemblies; a site for postirradiation examination; and the amount of plutonium, if any, to be fabricated into MOX fuel).

1.4 ISSUES IDENTIFIED DURING THE SCOPING PERIOD

In mid-1997, DOE conducted a public scoping process to solicit comments on its NOI concerning the disposition of surplus plutonium. Written comments were requested from the public via U.S. mail, fax, and Web site, and

[9] A MOX lead assembly is a prototype reactor fuel assembly that contains MOX fuel.

[10] Should the No Action Alternative be chosen, the ROD pursuant to this SPD EIS would also address the movement of the remaining surplus nonpit plutonium from RFETS in support of its planned closure in 2006.

oral comments were collected via telephone and at four public scoping meetings. During June and July 1997, about 640 people attended the scoping meetings held near the candidate sites for disposition facilities. The specific locations of the meetings were Idaho Falls, Idaho (near INEEL); Amarillo, Texas (near Pantex); North Augusta, South Carolina (near SRS); and Richland, Washington (near Hanford). These meetings were designed to provide a forum in which participants could discuss issues directly with DOE program officials, and DOE could solicit relevant input from affected or interested local and regional stakeholders. The meetings were conducted in a workshop format, providing stakeholders with numerous opportunities to learn about the issues and express their comments and concerns. Each workshop consisted of a short plenary session, followed by discussion groups and summarizing remarks. The comments provided at the scoping meetings were documented and used in the development of this SPD EIS.

A database was created to track written and oral comments received during the scoping process. More than 1,400 individual documents, culminating in 2,000 comments, were received and recorded in the database. An analysis was conducted of the comments received during the scoping process. They were initially grouped in the following seven areas: *proposed action, alternatives, facilities/technologies, impact, costs, public involvement*, and *other*. Comments were further categorized into four major groups according to their relationship to the scope of this SPD EIS: *already intended for inclusion in this SPD EIS, needs to be addressed in this SPD EIS, needs to be or is already addressed elsewhere*, and *other*. The following summary describes some of the major issues identified during the scoping process.

Issues Already Intended for Inclusion in This SPD EIS. Many comments received during the scoping process concern issues that were already intended to be included in this SPD EIS. For example, many commentors expressed concern over the potential environmental impacts of the various technologies at the candidate sites and requested that an in-depth analysis be conducted to determine the potential impacts. A concern was also expressed that making can-in-canister the preferred immobilization technology without an evaluation of alternative technologies circumvents the NEPA process. Other commentors recommended that this SPD EIS include a detailed accounting of the wastes that will be generated and the location of their ultimate disposal. A number of commentors were concerned that existing legal agreements with State governments and other agencies (e.g., triparty agreements) would be overlooked and possibly ignored. Other commentors addressed the quantity of plutonium to be immobilized or fabricated into MOX fuel. DOE is addressing all of these issues in this SPD EIS.

Additional Issues That Need to Be Addressed in This SPD EIS. A few commentors suggested that additional issues be considered in this SPD EIS. [Text deleted.] Some commentors suggested that Pantex be considered as a candidate site for the pit conversion facility under all situations, including the 50-t (55-ton) immobilization option, because most of the surplus pits are currently located there. In response to these comments, DOE added two alternatives to the SPD Draft EIS for the option of immobilizing all 50 t (55 tons) of surplus plutonium. Initially, the alternatives included siting both the pit conversion and immobilization facilities at one site (i.e., Hanford or SRS). The two new alternatives include Pantex as a candidate site for the pit conversion facility.

Issues That Need to Be or Are Already Addressed Elsewhere. Many comments received during the scoping process concern issues that are beyond the scope of this SPD EIS but are being or will be addressed elsewhere. These issues include the relationship of plutonium disposition and tritium production, and use of the Fast Flux Test Facility (FFTF) at Hanford solely for surplus plutonium disposition. The SPD EIS does not address using FFTF because the current DOE proposals do not include the use of surplus plutonium as a fuel source for FFTF.[11]

[11] DOE announced in a Notice of Intent (NOI) published September 15, 1999 (64 FR 50064), that it will prepare a programmatic EIS to evaluate the environmental effects associated with, among other options, the restart and operation of FFTF to meet the need for a range of research and development activities, medical isotope production, and plutonium 238 production to fuel National Aeronautics and Space Administration spacecraft.

A question was raised as to the role of the U.S. Nuclear Regulatory Commission (NRC) licensing requirements in regard to plutonium disposition facilities. Suggestions were made to include NRC processes in the SPD EIS. The NRC is a "commenting" agency on the SPD EIS. DOE provided copies of the SPD Draft EIS, *Supplement*, and SPD Final EIS to NRC for review and comment, and DOE is conducting regular meetings with NRC on the MOX approach, including fuel design and qualification.[12] In addition, an NRC license would be sought for the MOX facility. Domestic, commercial reactors operate under NRC licenses, and their proposed use of MOX fuel would be subject to review by NRC.

Some questions and concerns were also raised about the MOX fuel fabrication and reactor irradiation services procurement. (See Section 2.1.3 for a discussion of the procurement process and associated NEPA activities.) Many commentors suggested that DOE, in either this SPD EIS or other program studies, analyze the total cost of each alternative, including facility construction and modification, operations, and D&D, as well as all related site infrastructure costs. At the same time the SPD Draft EIS was issued, DOE released a cost study (DOE 1998a) focusing on site-specific costs to support site selection. As a followup to this study, DOE prepared a second report (DOE 1999b) that compiles life-cycle costs for the Preferred Alternative and addresses cost-related public comments.[13] These cost studies will be considered, along with the SPD EIS analyses, in the DOE decisionmaking process. Some commentors suggested that the potential impacts of the disposal of spent nuclear fuel generated by MOX fuel use be included in this SPD EIS. This issue has already been addressed in the *Storage and Disposition PEIS*, and disposal of spent nuclear fuel is addressed in the *Draft Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada* (DOE 1999c).[14]

Other. Many of the comments received were expressions of opinion or comments not directly related to issues addressed in this SPD EIS. For example, opposition was expressed by both U.S. and Canadian citizens to using CANDU reactors. Similarly, a number of commentors expressed their support for or opposition to immobilization and MOX technologies. Others expressed support for specific facilities or questioned the viability of site-specific facilities for pit conversion, immobilization, or MOX fuel fabrication. A number of commentors expressed their concern over the market viability of MOX fuel, even though MOX fuel would not be sold on the open market. Some commentors expressed their support for a hybrid disposition approach using both immobilization and MOX fuel fabrication.

1.5 SCOPE OF THIS SPD EIS

Site-specific issues associated with siting, construction, and operation of the three surplus plutonium disposition facilities are analyzed in this SPD EIS. The three facilities would be designed so that they could collectively accomplish disposition of up to 50 t (55 tons) of surplus plutonium over their operating lives, as shown in Figure 1–2. When the missions of the plutonium disposition facilities are completed, deactivation

[12] DOE did not receive any comments from NRC on the SPD Draft EIS or *Supplement*.

[13] These two cost reports are available on the Office of Fissile Materials Disposition Web site at http://www.doe-md.com, in the public reading rooms at the candidate sites, and upon request.

[14] For purposes of this SPD EIS, a potential geologic repository candidate site at Yucca Mountain, Nevada, was assumed to be the final disposal site for all immobilized plutonium and spent fuel. Currently, Yucca Mountain is the only site being characterized as a potential geologic repository. In August 1999, DOE issued a separate EIS, the *Draft Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada* (DOE/EIS-0250D) (DOE 1999c), to analyze the site-specific environmental impacts from construction, operation and monitoring, and eventual closure of a potential geologic repository at Yucca Mountain.

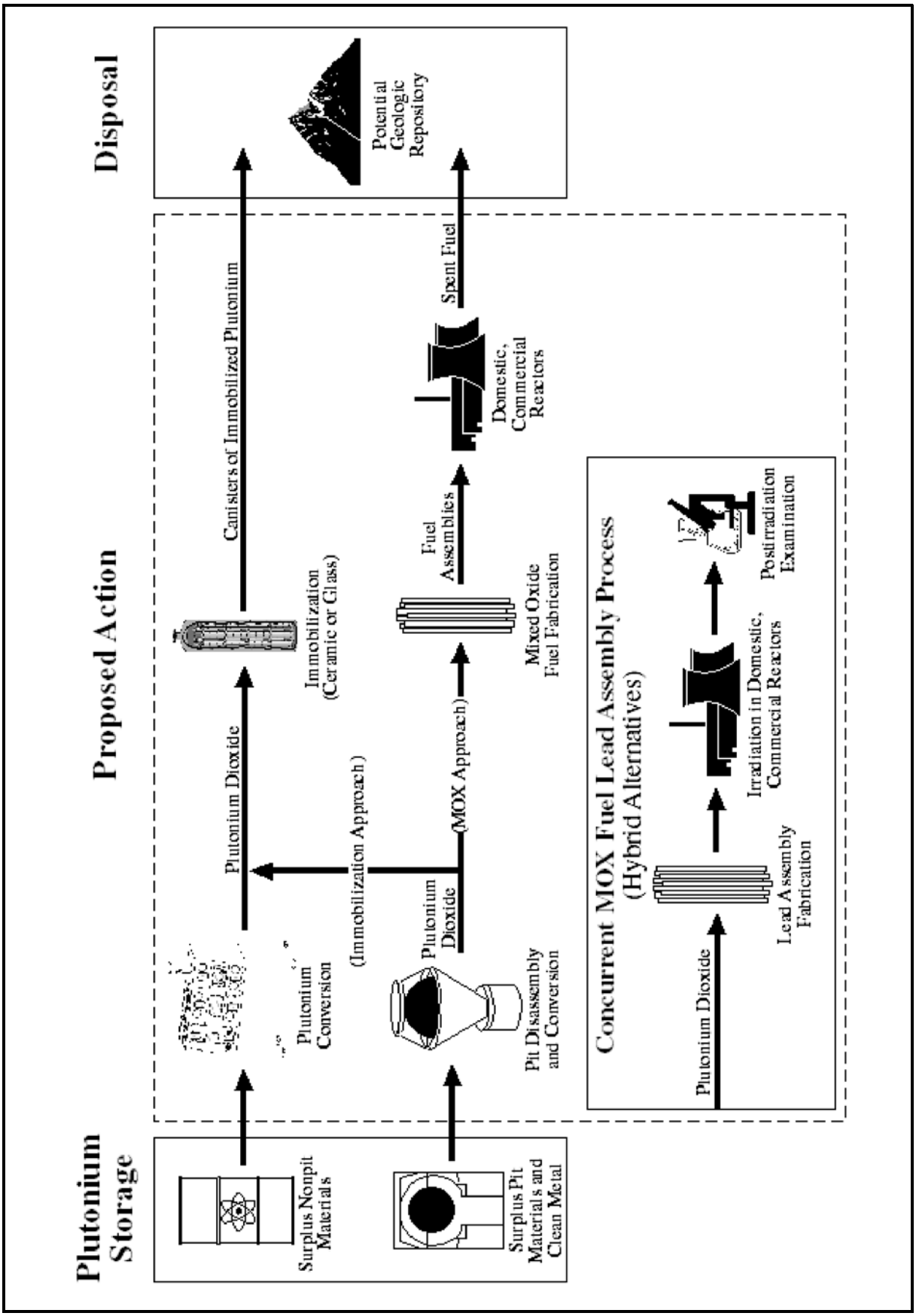


Figure 1–2. Proposed Surplus Plutonium Disposition Processes

and stabilization would be performed to reduce the risk of radiological exposure; reduce the need for and costs associated with long-term maintenance; and prepare the building for potential future use. (See Section 4.31.1 for a discussion on deactivation and stabilization.) At the end of the useful life of the facilities, DOE would evaluate options for D&D or reuse of the facilities. When DOE is ready for D&D of these facilities, an appropriate NEPA review will be conducted. (See Section 4.31.2 for a discussion of D&D.) This SPD EIS also analyzes transportation, including the following (see Section 2.4.4 for a more detailed discussion): plutonium from storage locations to the pit conversion facility or the immobilization facility, depending on the material and the alternative; plutonium dioxide from the pit conversion facility to the immobilization or MOX facility; recovered HEU from the pit conversion facility to Oak Ridge Reservation (ORR); depleted uranium hexafluoride from a representative DOE site to a representative commercial conversion facility (see Sections 2.4.4.2 and 2.4.4.3 for a more detailed discussion); uranium feed supply (uranium dioxide) from a representative commercial conversion facility to the immobilization and/or MOX fuel fabrication facilities and lead assembly facility; uranium fuel rods from a commercial fuel fabrication facility to the MOX facility and lead assembly facility; plutonium dioxide from LANL to the lead assembly facility; irradiated lead assemblies or rods from a reactor to the postirradiation examination site; spent fuel from the postirradiation examination site to INEEL for storage; MOX fuel to a commercial reactor; and immobilized plutonium to a potential geologic repository.[15] In addition to the various disposition alternatives, a No Action Alternative is also analyzed. In this alternative, disposition would not occur, and surplus plutonium would remain in long-term storage in accordance with the storage approach identified in the *Storage and Disposition PEIS* ROD.[16] For all alternatives analyzed in this SPD EIS, it is assumed that storage actions described in the *Storage and Disposition PEIS* ROD, as amended, have been accomplished.[17] Because this SPD EIS tiers from the analyses and decisions reached in association with the *Storage and Disposition PEIS*, information relevant to disposition options or candidate sites is incorporated by reference and summarized; it is not repeated here. [Text deleted.]

As part of the assessment of the MOX alternatives, this SPD EIS analyzes the fabrication of up to 10 lead assemblies that may be needed to support the MOX fuel program, although DOE plans to produce only 2. (See Sections 2.18.2 and 4.27 for a discussion of how impacts would be lower if only two lead assemblies were fabricated.) Existing DOE facilities at five candidate sites are analyzed, as is the transportation of feed materials to the lead assembly fabrication sites and the fabricated lead assemblies to a domestic, commercial reactor for test irradiation. Postirradiation examination may be required to support NRC licensing activities related to the use of MOX fuel in domestic, commercial reactors. This SPD EIS discusses postirradiation examination at two candidate sites, ANL–W and ORNL. These two sites are currently the only sites that possess the capability to conduct postirradiation activities without major modifications to facility and processing capabilities; only minor modifications for receipt of materials would be required. Other potential facilities, either within the DOE complex or in the commercial sector, would require significant modifications to meet expected requirements of the postirradiation examination.

---

[15] Shipments of spent fuel are analyzed in the *Draft Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada* (DOE/EIS-0250D) (DOE 1999c).

[16] Should the No Action Alternative be chosen, the ROD pursuant to this SPD EIS would also address the movement of the remaining surplus nonpit plutonium from RFETS in support of its planned closure in 2006.

[17] Recent studies indicated that cost savings could be realized from the transfer of nonpit materials from RFETS and Hanford to SRS earlier than specified in the *Storage and Disposition PEIS* ROD. A Supplement Analysis was prepared, and based on this analysis, DOE determined that a supplemental PEIS would not be needed; an amended ROD was issued in August 1998 (63 FR 43386) and included decisions to accelerate shipment of all nonpit surplus plutonium from RFETS to SRS and to relocate all Hanford surplus plutonium to SRS, if SRS is selected as the immobilization disposition site.

The ceramic immobilization, MOX fuel fabrication, and lead assembly processes require the use of uranium dioxide as a feed material, which can be obtained from either natural or depleted uranium. Because DOE has a large inventory of depleted uranium hexafluoride (the equivalent of 385,000 t [424,385 tons] of depleted uranium dioxide), this SPD EIS analyzes the use of a small amount of that inventory (about 137 t [151 tons] per year) to produce uranium dioxide (White 1997:1).[18, 19] Depleted uranium hexafluoride is currently stored at three DOE sites: the East Tennessee Technology Park in Oak Ridge, Tennessee; the Paducah Gaseous Diffusion Plant near Paducah, Kentucky; and the Portsmouth Gaseous Diffusion Plant (Portsmouth) near Piketon, Ohio. For purposes of analysis in this SPD EIS, Portsmouth is used as a representative site for a source of depleted uranium hexafluoride.[20] Included for evaluation in this SPD EIS are the activities necessary to package the depleted uranium hexafluoride for shipment to a representative commercial conversion facility (for purposes of analysis, this SPD EIS uses the General Electric Company's Nuclear Energy Production Facility in Wilmington, North Carolina) for conversion to uranium dioxide,[21] to transport the depleted uranium hexafluoride from Portsmouth to Wilmington, and to transport the uranium dioxide from Wilmington to the candidate immobilization, MOX fuel fabrication, and lead assembly sites (i.e., ANL–W, Hanford, INEEL, LLNL, LANL, Pantex, and SRS).

DOE's NOI announcing the preparation of this SPD EIS includes a table outlining 12 originally proposed disposition alternatives. Each alternative identifies the facilities, new or existing, at each candidate site that would be analyzed in this SPD EIS. [Text deleted.] Since the publication of the NOI, DOE further increased the number of alternatives for SPD EIS analysis to include a new MOX facility at Hanford, in addition to the alternative involving modifying the Fuels and Materials Examination Facility. For the option of immobilizing all 50 t (55 tons) of surplus plutonium, DOE also included Pantex as a candidate site for pit disassembly and conversion activities, making a total of four 50-t (55-ton) all-immobilization alternatives in the SPD Draft EIS. Previously, only Hanford and SRS had been considered as sites for pit disassembly and conversion activities for the 50-t (55-ton) all-immobilization case. Eight alternatives using a portion of Building 221–F at SRS for the immobilization facility that were analyzed in the SPD Draft EIS have been eliminated from this SPD Final EIS because the amount of space required for the immobilization facility would be significantly larger than originally planned. These eight alternatives are no longer considered reasonable because the new construction required for the proposed immobilization facility is now expected to be nearly the same whether the facility is entirely located in a new building or is built in addition to using a portion of Building 221–F at SRS. There are now 15 action alternatives presented as 11 sets of alternatives, plus the No Action Alternative. For a more detailed discussion of alternative development, see Section 2.3.

As indicated in the ROD for the *Storage and Disposition PEIS*, this SPD EIS analysis provides, in part, the basis for determining a specific immobilization technology. This SPD EIS analyzes in detail the proposed can-in-canister approach and compares the results with the impacts predicted in the *Storage and Disposition PEIS* for the homogenous immobilization approach in new ceramic immobilization and vitrification facilities.

---

[18] The contractor chosen by DOE to conduct MOX fuel fabrication has the option of acquiring uranium dioxide from another source.

[19] Potential use of depleted uranium hexafluoride or facilities at the gaseous diffusion plants will be consistent with the *Final Programmatic Environmental Impact Statement for Alternative Strategies for the Long-Term Management and Use of Depleted Uranium Hexafluoride* (DOE/EIS-0269, April 1999; ROD, August 1999) and the *Final Plan for the Conversion of Depleted Uranium Hexafluoride, As Required by Public Law 105–204* (DOE, July 1999).

[20] The Portsmouth Gaseous Diffusion Plant is used as a representative site because it is the only one of the three DOE sites that is currently capable of transferring the depleted uranium hexafluoride from the 12.7-t (14-ton) tails cylinders in which it is currently stored to the 2.28-t (2.5-ton) feed cylinders that are compatible with the processing equipment at a commercial facility (White 1997:5). However, DOE has no preference as to where the depleted uranium is acquired.

[21] Possible existing sites for this conversion facility include nuclear fuel fabrication facilities in Missouri, North Carolina, South Carolina, Washington, or a uranium conversion facility in Illinois. For purposes of analysis in this SPD EIS, the commercial nuclear fuel fabrication facility in Wilmington, North Carolina, is used as a representative site. DOE has no preference as to where conversion would occur.

In addition, for the can-in-canister approach, this SPD EIS separately analyzes the effects of immobilizing plutonium into either a titanate-based ceramic material or a lanthanide borosilicate glass.

To further define the potential processes to be used for the disposition of surplus plutonium, several research and development (R&D) activities are ongoing. A discussion of these R&D activities is provided in the *Pit Disassembly and Conversion Demonstration Environmental Assessment and Research and Development Activities* (DOE 1998b; Finding of No Significant Impact [FONSI], August 1998). Several of these R&D activities are likely to continue after the ROD for this SPD EIS is issued.

1.6 PREFERRED ALTERNATIVES

DOE's Preferred Alternative for the disposition of surplus weapons-usable plutonium is Alternative 3: to disposition up to 50 t (55 tons)[22] of plutonium at SRS using a hybrid approach that involves both the ceramic can-in-canister immobilization approach and the MOX approach. Approximately 17 t (19 tons) would be immobilized in a ceramic form, placed in cans, and embedded in large canisters containing high-level vitrified waste for ultimate disposal in a potential geologic repository pursuant to the NWPA. Approximately 33 t (36 tons) would be used to fabricate MOX fuel, which would be irradiated in existing domestic, commercial reactors. The proposed reactors are the Catawba Nuclear Station near York, South Carolina; the McGuire Nuclear Station near Huntersville, North Carolina; and the North Anna Power Station near Mineral, Virginia.[23] The resulting spent fuel would be placed in a potential geologic repository pursuant to the NWPA.

Pursuing the hybrid approach provides the best opportunity for U.S. leadership in working with Russia to implement similar options for reducing Russia's excess plutonium in parallel. Further, it sends the strongest possible signal to the world of U.S. determination to reduce stockpiles of surplus weapons-usable plutonium as quickly as possible and in a manner that would make it technically difficult to use the plutonium in weapons again. Pursuing both immobilization and MOX fuel fabrication also provides important insurance against uncertainties of implementing either approach by itself. The construction of new facilities for the disposition of surplus U.S. plutonium would not take place unless there is significant progress on plans for plutonium disposition in Russia.

DOE's preference for siting plutonium disposition facilities is as follows:

- **Pit Disassembly and Conversion at SRS.** Construct and operate a new pit conversion facility at SRS for the purpose of disassembling nuclear weapons pits and converting the plutonium metal to a declassified oxide form suitable for international inspection and disposition using either immobilization or MOX/reactor approaches. SRS is preferred for the pit conversion facility because the site has extensive experience with plutonium processing, and the pit conversion facility complements existing missions and takes advantage of existing infrastructure.

  [Text deleted.]

[22] Some materials are already in a final disposition form (i.e., irradiated fuel) and will not require further action before disposal. These materials are not included in this SPD EIS.

[23] No facility construction or MOX fuel fabrication or irradiation is to occur until the SPD EIS ROD is issued. Additionally, no MOX fuel is to be irradiated until NRC amends the operating license of each selected reactor prior to the specific reactor receiving the MOX fuel. Such site-specific activities would depend on decisions in the ROD, and DOE's exercise of contract options to allow such activities would be contingent on the ROD.

- **Immobilization at SRS (new construction and Defense Waste Processing Facility).**[24] Construct and operate a new immobilization facility at SRS using the ceramic can-in-canister technology. This technology would immobilize plutonium in a ceramic form, seal it in cans, and place the cans in canisters filled with borosilicate glass containing radioactive high-level waste (HLW) at the existing Defense Waste Processing Facility (DWPF). This preferred can-in-canister approach at SRS complements existing missions, takes advantage of existing infrastructure and staff expertise, and enables DOE to use an existing facility (DWPF). SRS was previously designated to be part of DOE's Preferred Alternative for immobilization in the NOI issued in May 1997. The ceramic can-in-canister approach would involve slightly lower environmental impacts than the homogenous approach (wherein the plutonium is incorporated into a homogenous mixture of plutonium and fission products in a single waste form). The ceramic can-in-canister approach would involve better performance in a potential geologic repository due to the ceramic form's expected higher durability under repository conditions and its lower potential for long-term criticality. In addition, it would provide greater proliferation resistance than the glass can-in-canister approach because recovery of plutonium from the ceramic form would require a more chemically complex process than has yet been developed.

- **MOX Fuel Fabrication at SRS (new construction).** Construct and operate a new MOX facility at SRS and produce MOX fuel containing surplus weapons-usable plutonium for irradiation in existing, domestic, commercial reactors. SRS is preferred for the MOX facility because this activity complements existing missions and takes advantage of existing support infrastructure and staff expertise. [Text deleted.]

- **Lead Assembly Fabrication at LANL.** Based on the consideration of capabilities of the candidate sites and input from the contractor team chosen for the MOX approach (the MOX procurement process is discussed in Chapter 2), DOE prefers LANL for lead assembly fabrication. LANL is preferred because it already has fuel fabrication facilities that would not require major modifications, and takes advantage of existing infrastructure and staff expertise. Additionally, the surplus plutonium dioxide that would be used to fabricate the lead assemblies would already be in inventory at the site.

- **Postirradiation Examination at ORNL.** If postirradiation examination is necessary for the purpose of qualifying the MOX fuel for commercial reactor use, DOE prefers to perform that task at ORNL. ORNL has the existing facilities and staff expertise needed to perform postirradiation examination as a matter of its routine activities; no major modifications to facilities or processing capabilities would be required. In addition, because ORNL is about 500 km (300 mi) from the McGuire Nuclear Station, the reactor that would irradiate the fuel, it is the closest candidate site for postirradiation examination activities.

[Text deleted.]

[24] DOE is presently considering replacement alternatives for the In-Tank Precipitation (ITP) process at SRS. The ITP process was intended to separate soluble high-activity radionuclides from liquid HLW before vitrifying the high-level fraction in DWPF. Due to problems experienced with the operation of ITP as configured, DWPF is currently operating with sludge feed only. A supplemental EIS on DWPF operation is being prepared that analyzes three proposed alternatives: small tank precipitation, ion exchange, and direct grout. See Section 2.4.2.1 for a more detailed discussion of these alternatives.

1.7 SUMMARY OF MAJOR ISSUES IDENTIFIED DURING THE COMMENT PERIODS AND CHANGES TO THE SPD DRAFT EIS

1.7.1 Public Involvement Process for the SPD Draft EIS and the *Supplement to the SPD Draft EIS*

DOE issued the SPD Draft EIS in July 1998 and received public comments. The comment period ran from July 17, 1998, through September 16, 1998, although DOE considered all comments submitted after the close of the 60-day comment period. In August 1998, DOE held five public hearings at the following locations in the vicinity of the four candidate DOE sites and at one regional location:

Richland, Washington	August 4, 1998
Amarillo, Texas	August 11, 1998
North Augusta, South Carolina	August 13, 1998
Portland, Oregon	August 18, 1998
Idaho Falls, Idaho	August 20, 1998

DOE received comments on the SPD Draft EIS by mail, a toll-free telephone and fax line, the Office of Fissile Materials Disposition Web site, and at the public hearings. Altogether, DOE received approximately 3,400 comment documents from individuals and organizations. All comments are presented in Volume III, Parts A and B, of the Comment Response Document of this SPD Final EIS. Approximately 65 percent of the comments received consisted of mail-in postcard campaigns that expressed either support of or opposition to the use of various sites or technologies. About 12 percent were collected during public hearings, 10 percent were in letters received by mail, 10 percent were received by fax, 2 percent were received by telephone, and 1 percent were received through the Web site.

In April 1999, DOE issued the *Supplement* and received public comments. The comment period ran from May 14, 1999, through June 28, 1999, although DOE considered all comments received after the close of the 45-day comment period. On June 15, 1999, DOE held a public hearing in Washington, D.C. DOE received approximately 77 comment documents from individuals and organizations, which are presented in Volume III, Part B, of the Comment Response Document of this SPD Final EIS. Approximately 21 percent of the comments received were collected during the public hearing, 34 percent were in letters received by mail, 26 percent were received by fax, 5 percent were received by telephone, and 14 percent were received through the Web site.

1.7.2 Summary of Major Issues Raised on the SPD Draft EIS During the Public Comment Period

The following paragraphs highlight comments and issues that the public raised concerning information provided in the SPD Draft EIS. These comments were collected during the two separate public comment periods for the SPD Draft EIS and the *Supplement*. (Comments received on information specifically provided in the *Supplement* are summarized in Section 1.7.3.) Changes made to this SPD EIS in response to a comment are described.

Russian Disposition Program. A number of commentors expressed concern over Russian disposition activities and tying U.S. activities to Russian activities. The United States and Russia recently made progress in the management and disposition of plutonium. In July 1998, Vice President Gore and Russian Prime Minister Sergei Kiriyenko signed a 5-year agreement to provide the scientific and technical basis for decisions concerning how surplus plutonium will be managed. In September 1998, Presidents Clinton and Yeltsin held a Moscow summit and signed a statement of principles with the intention of removing approximately 50 t (55 tons) of plutonium from each country's stockpile. The United States does not currently plan to implement a unilateral program; however, it will retain the option to begin certain disposition activities in order to encourage the Russians and set an international example. DOE has updated this SPD EIS to reflect the agreement and statement of principles and included copies in Appendix A.

Site Selection. A large number of comments were received advocating one candidate site over another for various reasons, including the presence of existing facilities that could prove beneficial to plutonium disposition, skilled workers, safety records, reduced transportation, and perceived economic benefits. DOE has chosen SRS as its preferred site for the three surplus plutonium disposition facilities, as outlined in Section 1.6.

Approach to Plutonium Disposition. A number of commentors protested DOE's preference for the hybrid approach and the use of MOX fuel for surplus plutonium disposition. Among the comments received on this issue were many advocating the use of the immobilization approach for all of the surplus plutonium. Commentors argued that the immobilization approach was safer, cheaper, and faster. They also pointed out that the immobilization approach resulted in less transportation. Because specific reactors in North Carolina, South Carolina, and Virginia have been proposed for plutonium disposition, the transportation requirements associated with several hybrid alternatives that include the MOX facility at SRS and Pantex have decreased (because the proposed reactors are closer to these sites than the 4,000-km [2,500-mi] bounding distance analyzed in the SPD Draft EIS). As a result, these hybrid alternatives would require less transportation than some of the 50-t (55-ton) immobilization alternatives. Other commentors viewed the MOX approach as a Federal Government subsidy of the commercial nuclear power industry. Use of MOX fuel in domestic, commercial reactors is not proposed in order to subsidize the commercial nuclear power industry. Rather, the purpose is to safely and securely disposition surplus plutonium by meeting the Spent Fuel Standard.[25]

Safety and Health. Comments were received that questioned the safety and health aspects of operating the surplus plutonium disposition facilities. Commentors pointed out that DOE's safety record at other nuclear facilities had been poor in the past and questioned DOE's ability to safely operate the disposition facilities. The health and safety of workers and the public is a priority of the surplus plutonium disposition program, regardless of which approach is chosen. Operation of the disposition facilities would comply with applicable Federal, State, and local laws and regulations governing radiological and hazardous chemical releases. Within these limits, DOE believes that the radiation exposure and the level of contamination should be kept as low as is reasonably achievable.

Aqueous Processing of Plutonium. Some commentors questioned DOE's ability to produce clean plutonium dioxide that could be used in MOX fuel using the dry process proposed in the SPD Draft EIS. Questions were raised about the ability of this process to remove gallium and other pit materials from the plutonium before it is fabricated into MOX fuel. On the basis of public comments received on the SPD Draft EIS and the analysis performed as part of the MOX procurement, DOE has included plutonium polishing (a small-scale aqueous process) as a component of the MOX facility to ensure adequate impurity removal from the plutonium dioxide. Appendix N (which addressed plutonium polishing in the SPD Draft EIS) was deleted from this SPD Final EIS, and the impacts discussed therein were included in the impacts presented for the MOX facility in Chapter 4. Section 2.4.3 was also revised to include a discussion of plutonium polishing.

No attempt was made to evaluate the use of DOE's existing aqueous processing lines capable of dissolving pits, as advocated by some commentors. DOE determined that such aqueous processing, while a proven technology, is not a reasonable alternative for pit conversion because current aqueous processes using existing facilities would produce significant amounts of waste, and aqueous processing would complicate international inspection regimes because of classification issues.

[25] "Spent Fuel Standard" is a term coined by the National Academy of Sciences (NAS, 1994, *Management and Disposition of Excess Weapons Plutonium*, National Academy Press, Washington, D.C., pg.12.) and modified by DOE (glossary from Office of Fissile Materials Disposition Web site at http://www.doe-md.com) denoting the main objective of alternatives for the disposition of surplus plutonium: that such plutonium be made roughly as inaccessible and unattractive for weapons use as the much larger and growing stock of plutonium in civilian spent nuclear fuel.

Reprocessing. Several comments were received related to the reprocessing of plutonium and the civilian use of plutonium. The use of U.S. surplus plutonium in existing domestic, commercial reactors does not involve reprocessing. The proposed use of MOX fuel is consistent with the U.S. nonproliferation policy and would ensure that plutonium that was produced for nuclear weapons and subsequently declared excess to national security needs is never again used for nuclear weapons. The MOX facility would be built and operated subject to the following strict conditions: construction would take place at a secure DOE site, it would be owned by the U.S. Government, operations would be limited exclusively to the disposition of surplus plutonium, and the MOX facility would be shut down at the completion of the surplus plutonium disposition program. At the end of the useful life of the facility, DOE would evaluate options for D&D or reuse of the facility for other purposes.

Inclusion of Generic Reactor Information in the SPD Draft EIS. Many comments were received on the inclusion of generic reactor information in the SPD Draft EIS. At the time the Draft was released, DOE did not know which specific reactors would be proposed for the MOX program. Subsequently, the Catawba, McGuire, and North Anna reactors were chosen as part of the contractor team that would implement the MOX option should the decision be made in the SPD EIS ROD to go forward with the hybrid approach (i.e., both immobilization and MOX). Specific reactor information provided as part of the procurement process was evaluated by DOE in an Environmental Critique in accordance with DOE's NEPA regulations at 10 CFR 1021.216. The Environmental Critique was considered by DOE before awarding the contract. An Environmental Synopsis based on the Environmental Critique was prepared and released to the public for comment in the *Supplement*. The comments received on the *Supplement* are summarized and responded to in Volume III, Part B, of the Comment Response Document. An opportunity for public comment will also likely be provided by NRC during the reactor operating license amendment process.

Transportation Concerns. Commentors raised concerns about the transportation involved with moving the surplus plutonium from storage locations to disposition sites and, in some cases, MOX fuel to reactor sites. Requests were made to limit the transportation where possible, to present the transportation information in a more understandable manner, and to ensure that the transportation was conducted as safely as possible. Additional information has been added to Chapter 2 of this SPD Final EIS, which shows the total transportation associated with each alternative and gives a graphic depiction of the transportation needed for each disposition approach (immobilization and MOX). As discussed in this SPD EIS, safe transportation is a major concern of DOE. All shipments of surplus plutonium would be accomplished using the safe, secure trailer/SafeGuards Transport (SST/SGT) system.[26] Since the establishment of the DOE Transportation Safeguards Division in 1975, the SST/SGT system has transported DOE-owned cargo over more than 151 million km (94 million mi) with no accidents that resulted in a fatality or release of radioactive material.

Cost of Plutonium Disposition. Many commentors focused on the cost of various surplus plutonium disposition facilities. Because cost issues are beyond the scope of this SPD EIS, commentors are referred to DOE's *Cost Analysis in Support of Site Selection for Surplus Weapons-Usable Plutonium Disposition* (DOE 1998a) and *Plutonium Disposition Life-Cycle Costs and Cost-Related Comment Resolution Document* (DOE 1999b). Comments concerning the basis for DOE's cost estimates or requesting cost information were forwarded to DOE's cost analysis team.

[26] The SST/SGT is a specially designed component of an 18-wheel tractor-trailer vehicle. Although the details of the vehicle enhancements are classified, key characteristics are not, and include: enhanced structural supports and a highly reliable tie-down system to protect cargo from impact; heightened thermal resistance to protect the cargo in case of fire; deterrents to protect the unauthorized removal of cargo; couriers who are armed Federal officers and receive rigorous training and are closely monitored through DOE's Personnel Assurance Program; an armored tractor to protect the crew from attack; advanced communications equipment; specially designed escort vehicles containing advance communications and additional couriers; 24-hr-a-day real-time monitoring of the location and status of the vehicle; and significantly more stringent maintenance standards.

1.7.3 Summary of Major Issues Raised on the *Supplement to the SPD Draft EIS* During the Public Comment Period

Frequency of Reactor Accidents in Reactors Using MOX Fuel. A number of comments argued that the frequency of reactor accidents would be greater due to the use of MOX fuel. As reflected in the accident analysis included in Section 4.28, the consequences of a beyond-design-basis accident using MOX fuel are generally higher than those expected in the same reactor using low-enriched uranium (LEU) fuel. However, there is no basis for concluding that the frequency of these accidents would increase due to the use of MOX fuel. During the base contract period, the contractor team would work with the utilities to confirm the characteristics of the MOX fuel and whether any design modifications are necessary to maintain safety margins. No change in the frequencies of reactor accidents due to the use of MOX fuel has been made in this SPD Final EIS.

Risk Associated With Reactors Using MOX Fuel. Many commentors were concerned that there is an increase in accident risk from reactors using MOX fuel and that the plutonium in MOX fuel makes a reactor accident more dangerous to human health. There are differences in the expected risk of reactor accidents from the use of MOX fuel. Some accidents would be expected to result in lower consequences to the surrounding population, and thus, lower risks, while others would be expected to result in higher consequences and higher risks. The largest estimated increase in risk to the surrounding population due to the use of MOX fuel is an estimated 14 percent increase in the risk of latent cancer fatalities associated with an interfacing systems loss-of-coolant at North Anna. The likelihood of this accident occurring at North Anna is estimated to be one chance in 4.2 million per year. Before any MOX fuel is used for plutonium disposition, NRC would perform a comprehensive safety review that would include information prepared by the reactor plant operators as part of their license amendment applications. Expected risk is discussed in Section 4.28 of this SPD EIS.

Environmental Impacts Associated With Using MOX Fuel Versus LEU Fuel. Comments were received expressing a concern that the SPD Draft EIS failed to recognize avoided environmental impacts associated with using MOX fuel versus LEU fuel in existing commercial reactors. While the consequences of a beyond-design basis accident might be higher (as discussed above), and a slight increase in spent fuel could be expected by using MOX fuel instead of LEU fuel, the impacts associated with mining, milling, and enriching uranium are avoided. Section 4.28.3 has been added to this SPD Final EIS to address this issue.

Low-Level Waste. Comments were received on the isotopic breakdown of the low-level waste (LLW) that would be generated at the reactors using MOX fuel and the effect of this waste on existing burial grounds. There are differences in fission product inventories and activation products between an LEU and MOX core during a fuel cycle. However, the only time significant quantities of fission products could be released to the environment or end up in LLW would be in the event of a large-scale fuel leak. In regard to normal operations, experience with fabricating MOX fuel indicates a leakage rate of less than one-tenth of one percent. The use of MOX fuel would not be expected to result in any additional LLW because the reactors would continue to operate on the same schedule as if they were using only LEU fuel.

Public Hearings. A number of comments were received regarding the need to hold public hearings near the proposed reactor locations. DOE's NEPA regulations require that at least one public hearing be held to receive comments on a draft EIS (10 CFR Part 1021.313[b]). A public hearing was held in Washington, D.C., to collect public comments on the *Supplement*. No additional hearings were held near the specific reactor sites, but comments were solicited in the areas surrounding the proposed reactors. The *Supplement* was sent to interested groups and individuals near each of the reactors and an informational meeting about the proposed use of MOX fuel, sponsored by a South Carolina State Senator, was attended by DOE during the comment period. The transcript of this meeting is presented as Appendix A of the Comment Response Document.

1.7.4 Changes to the SPD Draft EIS and the *Supplement*

DOE revised the SPD Draft EIS and its *Supplement* in response to comments received from other Federal agencies; tribal, State, and local governments; nongovernmental organizations; the general public; and DOE reviews. The text was changed to provide additional environmental baseline information, reflect new technical data, make editorial corrections, respond to comments, and clarify text. Some of these changes involved recalculations of the impacts discussed in Chapter 4. In addition, DOE updated information due to events or decisions made since the SPD Draft EIS and *Supplement* were provided for public comment. Sidebars are used throughout this SPD Final EIS to indicate where changes have been made. Below is a brief discussion of significant (i.e., noneditorial) changes.

Revised Preferred Alternative. In the SPD Draft EIS, DOE's Preferred Alternative for siting the proposed disposition facilities was identified as either Alternative 3 (the pit conversion, immobilization, and MOX facilities at SRS) or Alternative 5 (the pit conversion facility at Pantex and the immobilization and MOX facilities at SRS). Under either alternative, the hybrid approach (i.e., immobilization and MOX) was preferred with the immobilization technology being the can-in-canister approach. No preference was identified in the SPD Draft EIS for the lead assembly or postirradiation examination activities, nor were the specific reactors that would use MOX fuel identified.

The *Supplement* identified SRS as the preferred site for the construction and operation of the pit conversion, immobilization, and MOX facilities. The *Supplement* also identified LANL as the preferred site for lead assembly activities and ORNL as the preferred site for postirradiation examination activities. Section 1.6 of this SPD Final EIS now identifies Alternative 3 as DOE's Preferred Alternative. In addition, Section 2.1.3 now identifies the three reactor sites that have been named as candidates for using MOX fuel subject to NRC license amendment. They are the Catawba Nuclear Station in York County, South Carolina; the McGuire Nuclear Station in Mecklenburg County, North Carolina; and the North Anna Power Station in Louisa County, Virginia.

Changes to the Immobilization Facility. Since the issuance of the SPD Draft EIS and as described in the *Supplement*, DOE has developed a more detailed conceptual design for the can-in-canister immobilization facility. Changes in the size of the immobilization facility have been reflected in Chapter 2 of this SPD Final EIS and the associated impact analyses throughout Chapter 4. No changes have been made to the basic processes proposed in the SPD Draft EIS for immobilization, to the amount of material being considered for immobilization, or to the rate of throughput.

As stated in the *Supplement*, the eight alternatives that included using portions of Building 221–F for immobilization (SPD Draft EIS Alternatives 3B, 5B, 6C, 6D, 7B, 9B, 12B, and 12D) were eliminated. These alternatives are no longer reasonable because the amount of new construction required for the proposed immobilization facility is now nearly the same whether the facility is located entirely in a new building or uses a portion of Building 221–F. Thus, there is no longer any advantage associated with the use of Building 221–F at SRS.

Changes Resulting From the MOX Procurement Process. As stated in the *Supplement*, information provided as part of the MOX procurement process relating to the MOX facility, including the addition of a plutonium-polishing module to the front end of the MOX facility, was analyzed by DOE in an Environmental Critique and summarized in an Environmental Synopsis prepared pursuant to DOE's NEPA regulations in 10 CFR 1021.216. The Synopsis was included in the *Supplement* and has been added to this SPD Final EIS as Appendix P. Appendix N, *Plutonium Polishing*, has been deleted from this SPD Final EIS, with the information in Appendix N incorporated into the body of the EIS. A description of the polishing module has been added to Section 2.4.3, and the impacts analysis has been incorporated into Chapter 4 of this SPD Final EIS. The polishing step is included in the MOX facility, so plutonium polishing is no longer considered as a contingency for the pit conversion facility.

As described in the *Supplement*, the size of the MOX facility has increased. The larger MOX facility is described in Chapter 2 of this SPD Final EIS, and the associated environmental impacts are presented throughout Chapter 4. No changes have been made in the amount of material proposed to be made into MOX fuel, the facility's throughput, or in the overall process to be used to fabricate the fuel.

Information related to the affected environment for the specific domestic commercial reactors that would irradiate the MOX fuel was provided in the *Supplement* and has been added to this SPD Final EIS as a new Section 3.7. Environmental impacts analyzed for the actual reactor sites was also provided in the *Supplement* and has been added to Section 4.28 of this SPD Final EIS.

Possible Delay of the Construction of the Actinide Packaging and Storage Facility. As stated in the *Supplement*, the schedule for the Actinide Packaging and Storage Facility (APSF) is uncertain at this time, and therefore, the disposition facilities at SRS analyzed in this SPD Final EIS were modified to disregard any benefit to the proposed facilities as a result of APSF being present. Chapter 4 of this SPD Final EIS presents the environmental impacts that would be associated with the construction and operation of surplus plutonium disposition facilities at SRS that are stand-alone and include no reliance on storage space or other functions at APSF. Throughout this SPD Final EIS, references to APSF have been qualified by the phrase "if built," and no credit has been taken in the environmental analyses for the presence of APSF.

Pit Repackaging Requirements. This SPD Final EIS was changed to reflect new decisions on the repackaging of pits at Pantex for long-term storage and the impacts of that decision on the need to repackage the pits for offsite transportation.

Pit repackaging for long-term storage. As discussed in the *Supplement*, work is currently under way to repackage all pits at Pantex from the AL–R8 container into the AL–R8 sealed insert (SI) container for long-term storage,[27] as described in the *Supplement Analysis for: Final Environmental Impact Statement for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components—AL–R8 Sealed Insert Container* (DOE 1998c). This effort would be completed over 10 years, and the estimated dose to involved workers received from this repackaging activity would be about 104 person-rem. The SPD Draft EIS analyzed repackaging of the pits in an AT–400A container. The change to the AL–R8 SI changes the undisturbed long-term storage period for pits from 50 to 30 years because of the need to replace a seal in the container after 30 years; the AT–400A does not require that activity. This change has been incorporated into Chapter 4.

Pit repackaging for offsite transportation. The AL–R8 SI is not an offsite shipping container as was the AT–400A analyzed in the SPD Draft EIS. Therefore, if the decision were made to site the pit conversion facility at a site other than Pantex, the surplus pits would have to be taken out of the AL–R8 SI and placed in a shipping container.[28] This operation would also require the replacement of some pit-holding fixtures to meet transportation requirements. It is expected that this change would result in a total repackaging dose to involved workers of 208 person-rem. If the decision were made to locate the pit conversion facility at Pantex, then the pits could be moved from their storage location to the pit conversion facility in the AL–R8 SI using onsite transportation

[27] DOE is considering leaving the repackaged surplus pits in Zone 4 at Pantex for long-term storage. An appropriate environmental review will be conducted when the specific proposal for this change has been determined (e.g., whether additional magazines need to be air-conditioned). The analysis in this document assumes that the surplus pits are stored in Zone 12 in accordance with the ROD for the *Storage and Disposition PEIS.*

[28] At the present time, DOE is using the FL container for the offsite shipment of pits. There are not enough of these containers to meet the plutonium disposition mission. No new FL containers can be manufactured because of certification restrictions. Further, the current FL containers cannot be certified for a specific type of surplus pit. The Defense Nuclear Facilities Safety Board, in its Recommendation 99–1 (August 1999), noted that there is no container suitable for shipping pits from Pantex. Should DOE make any decisions that would require shipment of pits from Pantex, DOE would ensure the availability of a certified shipping container in a timeframe that would support those decisions.

vehicles. Under this option, there would be no increased exposures due to repackaging. This change has been incorporated into Chapter 4.

Environmental Impacts Associated With MOX Fuel Versus LEU Fuel. Section 4.28.3 was added to this SPD Final EIS to address the impacts associated with using MOX fuel versus LEU fuel in existing commercial reactors.

Uranium Conversion Impacts. Section 4.30.3, Incremental Impacts Associated With Uranium Conversion, was added to address potential impacts of the conversion of depleted uranium hexafluoride to uranium dioxide. (See Sections 2.4.4.2 and 2.4.4.3 for a discussion on conversion.)

New/Revised Documents and Changes to Cumulative Impacts. Section 1.7 of the SPD Draft EIS, Relationship to Other Actions and Programs, (Section 1.8 in this Final) was updated to reflect new or revised planning documents and related NEPA documents, such as the *Environmental Assessment for the Parallex Project Fuel Manufacture and Shipment*, the *ROD for the Department of Energy's Waste Management Program: Treatment of Non-Wastewater Hazardous Waste*, the *Advanced Mixed Waste Treatment Project Final EIS* and ROD, and the *Final Environmental Impact Statement on Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site* and RODs. The information in the most recent programmatic and site documents has been used to update the discussion of cumulative impacts in Section 4.32 of this SPD Final EIS. In addition, cumulative impacts information has been added for LLNL and LANL (two candidate sites for lead assembly fabrication), ORNL (a candidate site for postirradiation examination), and the three reactor sites (Catawba, McGuire, and North Anna).

Affected Environment. Information on the affected environment for ORNL, a candidate site for postirradiation examination, has been added to Chapter 3 of this SPD Final EIS.

Consultations. Appendix O was added to provide the correspondence related to ecological resources, cultural resources, and Native American consultations. Table 5–2 provides a summary of these consultations, and Section 4.26 discusses the results of the consultations.

FFTF. Appendix D of the SPD Draft EIS was deleted. This SPD Final EIS does not address using FFTF because the current DOE proposals do not include the use of surplus plutonium as a fuel source for FFTF.

Comment Response. Volume III, the Comment Response Document, was added to this SPD Final EIS. The comments received during the two comment periods and their responses are presented in a side-by-side-format.

1.8 RELATIONSHIP TO OTHER ACTIONS AND PROGRAMS

The proposed plutonium disposition actions would require coordination with other ongoing DOE programs. This section provides brief summaries of NEPA and other planning documents related to these ongoing programs. Section 1.8.1 includes documents that deal directly with other aspects of the surplus plutonium disposition program, as well as documents from other programs that may provide feed materials for disposition activities. Other documents in this section analyze material treatment or stabilization activities at DOE sites that could yield weapons-usable fissile materials that would be dispositioned pursuant to the analysis in this SPD EIS. Section 1.8.2 includes documents that analyze the management of the various waste types across the DOE complex. Waste generated by the construction and operation of the proposed surplus plutonium disposition facilities would be managed in accordance with decisions made pursuant to the NEPA RODs of these documents. Also, some of the waste planning documents will reflect the waste management and environmental implications of the decisions made as a result of this SPD EIS. Section 1.8.3 highlights some of the documents that deal with

activities currently under way or planned for the SPD EIS candidate sites. The information in the most recent and programmatic site documents are considered in the cumulative impact assessment in Section 4.32.

1.8.1 Materials and Disposition Options

The *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement* (DOE/EIS-0229, December 1996) analyzes the environmental impacts of alternatives considered for the long-term storage of weapons-usable fissile materials (HEU and plutonium) and for the disposition of weapons-usable plutonium that has been declared surplus to national security needs. The ROD (January 1997) encompasses two categories of plutonium decisions: (1) the sites and facilities for the storage of nonsurplus plutonium and the storage of surplus plutonium pending disposition; and (2) the programmatic strategy for disposition of surplus plutonium. This ROD does not include the final selection of sites for plutonium disposition facilities or the extent to which the two plutonium disposition approaches (immobilization and MOX) will be ultimately implemented. (Those decisions will be based in part on the analysis in this tiered SPD EIS.) However, DOE does announce in the ROD that the list of candidate sites for plutonium disposition has been narrowed. It also announces the decision to store surplus and nonsurplus HEU in upgraded facilities at the Oak Ridge Reservation. DOE studies indicated that significant cost savings could be realized from the transfer of nonpit materials from RFETS and Hanford earlier than indicated in the *Storage and Disposition PEIS* ROD. DOE issued an amended ROD (August 1998) that supports the early closure of RFETS and the early deactivation of plutonium storage facilities at Hanford. The amended ROD includes decisions to accelerate shipment of all nonpit surplus plutonium from RFETS to SRS and the relocation of all Hanford surplus plutonium to SRS, if SRS were selected as the immobilization site. A supplement analysis to the *Storage and Disposition PEIS*, the *Supplement Analysis for Storing Plutonium in the Actinide Packaging and Storage Facility and Building 105–K at the Savannah River Site*, was issued in July 1998.

The *Pit Disassembly and Conversion Demonstration Environmental Assessment and Research and Development Activities* (DOE/EA-1207, August 1998; FONSI, August 1998) analyzes a proposed demonstration project at LANL to determine the feasibility of an integrated pit disassembly and conversion system as part of the surplus plutonium disposition strategy. This demonstration involves the disassembly of up to 250 pits and conversion of the recovered plutonium to plutonium metal ingots and plutonium oxide. The demonstration started in the fall of 1998 and will last up to 4 years. The results of the demonstration will help "fine-tune" the operational parameters of the pit conversion facility. The environmental assessment (EA) also describes ongoing R&D activities related to the disposition of surplus plutonium.

The *Environmental Assessment for the Parallex Project Fuel Manufacture and Shipment* (DOE/EA-1216, January 1999; FONSI, August 13, 1999) tiers from the *Storage and Disposition PEIS* and analyzes the fabrication and transport of a limited amount of U.S. MOX fuel to a Canadian reactor for test irradiation. Russian MOX fuel would also be irradiated as part of the experiment. The MOX fuel fabricated at LANL would be transported in U.S. Department of Transportation–approved containers by commercial carriers to a Canadian port of entry. At the Canadian border, Atomic Energy of Canada Limited (AECL) would take possession of the fuel and complete the shipment in the U.S. trucks to the National Research Universal (NRU) test reactor at Chalk River Laboratories in Chalk River, Ontario. The AECL would be responsible for conducting all subsequent fuel performance tests in the NRU reactor. All spent fuel resulting from the tests would be disposed of in Canada under the Canadian spent fuel program.

The *Final Environmental Impact Statement on Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site* (DOE/EIS-0277F, August 1998; ROD, November 1998; ROD, February 1999; Amended ROD, September 1999) evaluates the potential environmental impacts associated with reasonable management alternatives for certain plutonium residues and all scrub alloy currently stored at RFETS near Golden, Colorado. DOE previously decided to stabilize, if necessary, and

repackage the plutonium residues for safe interim storage at RFETS, as discussed in the *Solid Residue Treatment, Repackaging, and Storage Environmental Assessment* (DOE/EA-1120, April 1996; FONSI, April 1996). The management alternatives analyzed in the EIS are no action (which includes the application of variances to safeguards termination limits), processing without plutonium separation, and processing with plutonium separation. The ROD (November 1998) determined that the preferred alternative would be implemented, which includes (1) processing and packaging plutonium residues at RFETS in preparation for disposal at the Waste Isolation Pilot Plant (WIPP); and (2) packaging and shipping sand, slag, crucible and plutonium fluoride residues, and scrub alloy to SRS, where the materials would be stabilized in F-Canyon by chemically separating the plutonium from the remaining materials in the residues and scrub alloy. In a second ROD (February 1999), DOE decided to implement the preferred alternative specified in the final EIS for the remaining categories of materials. In an amended ROD (September 1999), DOE decided to ship the sand, slag, and crucible residues directly to WIPP and not the residues to SRS.

The *Final Programmatic Environmental Impact Statement for Alternative Strategies for the Long-Term Management and Use of Depleted Uranium Hexafluoride* (DOE/EIS-0269, April 1999; ROD, August 1999) evaluates the environmental impacts of six alternative strategies for the long-term management of DOE-owned depleted uranium hexafluoride currently stored at the East Tennessee Technology Park in Oak Ridge, Tennessee; the Paducah Gaseous Diffusion Plant near Paducah, Kentucky; and the Portsmouth Gaseous Diffusion Plant near Piketon, Ohio. These alternatives involve cylinder technology and design; conversion of depleted uranium hexafluoride to another chemical form; and materials use, storage, disposal, and transportation. As indicated in its ROD, DOE selected the preferred alternative, which is to begin conversion of the depleted uranium hexafluoride as soon as possible, either to uranium oxide, uranium metal, or a combination of both, while allowing for future use of as much of this inventory as possible. This SPD EIS analyzes the conversion of depleted uranium hexafluoride, from a representative site (Portsmouth), to uranium dioxide, which would be used as feedstock for immobilization and MOX fuel and lead assembly fabrication.

[Text deleted.]

1.8.2 Waste Management

The *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste* (WM PEIS) (DOE/EIS-0200-F, May 1997; Transuranic [TRU] Waste ROD, January 1998; Hazardous Waste ROD, August 1998) examines the potential environmental and cost impacts of strategic alternatives for managing five types of radioactive and hazardous wastes that have resulted, and will continue to result, from nuclear defense and research activities at a variety of sites around the United States. The WM PEIS provides information on the impacts of various siting configurations that DOE will use to decide at which sites to locate additional treatment, storage, and disposal capacity for each waste configuration. Any waste resulting from actions taken in this SPD EIS would be treated, stored, and disposed of in accordance with the RODs and other decisions resulting from the WM PEIS. To date, three RODs have been issued: for the treatment and storage of TRU waste (January 1998), for the treatment of hazardous waste (August 1998), and for the storage of HLW (August 1999). The TRU waste ROD determined that those DOE sites that currently have or will generate TRU waste will prepare it for storage and store it on the site, the only exception being that Sandia National Laboratory will transfer its TRU waste to LANL. The Hazardous Waste ROD decided that DOE will continue use of offsite facilities for the treatment of nonwastewater hazardous waste based on analysis from the WM PEIS. The Oak Ridge Reservation and SRS will treat some of their own nonwastewater hazardous waste on the site. The HLW ROD decided that immobilized HLW will be stored at Hanford, INEEL, SRS, and the West Valley Demonstration Project in New York until a geologic repository is licensed by NRC.

The *Waste Isolation Pilot Plant Final Environmental Impact Statement* (DOE/EIS-0026, October 1980; ROD, January 1981) and associated supplements (DOE/EIS-0026-S-1, January 1990; ROD, June 1990; and DOE/EIS-0026-S-2, September 1997; ROD, January 1998) analyze the development, operation, and transportation activities associated with WIPP, a mined repository for TRU waste near Carlsbad, New Mexico. TRU waste produced as a result of surplus plutonium disposition activities would be required to meet the WIPP waste acceptance criteria and would ultimately be disposed of at WIPP. This EIS covers transportation from all the SPD EIS candidate sites except Pantex. Therefore, transportation of TRU waste from Pantex to WIPP is analyzed in this SPD EIS.

The *Draft Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada* (DOE/EIS-0250D, July 1999) analyzes the construction, operation and monitoring, and eventual closure of a potential geologic repository at Yucca Mountain to dispose of commercial and DOE spent nuclear fuel, high-level radioactive waste, and materials that NRC determines by rule require the same degree of isolation. National transportation, Nevada transportation, and waste packaging are evaluated as part of the analysis. Three implementing design alternatives based on thermal load—low, intermediate, and high—are examined. High-level waste with immobilized plutonium and spent fuel produced from SPD EIS plutonium immobilization and MOX alternatives are included in the inventory analyzed in that EIS. This SPD EIS assumes for the purposes of analysis that Yucca Mountain is a potential geologic repository site.

The *Accelerating Cleanup: Paths to Closure* (DOE/EM-0362, June 1998) is DOE's blueprint for cleanup. It provides DOE's detailed projections on the scope, schedules, and costs for the cleanup of contaminated soil, groundwater, and facilities; treatment, storage, and disposal of waste; and effective management of nuclear materials and spent nuclear fuel. Included in the report are site waste and material disposition flow charts that describe each stream, the steps for processing or managing the wastes, and the permanent waste disposal sites that have been designated. This document is not a plan or a decisionmaking document; it describes the status and direction of DOE's draft cleanup strategy. Appropriate NEPA reviews will be conducted before any decisions are made. This SPD EIS reflects the proposals in *Paths to Closure* to the extent possible. Subsequent versions of *Paths to Closure* will reflect the waste management and environmental restoration implications of the decisions made as a result of this SPD EIS.

1.8.3 SPD EIS Candidate Sites

The *Tank Waste Remediation System, Hanford Site, Richland, Washington, Final Environmental Impact Statement* (TWRS EIS) (DOE/EIS-0189, August 1996; ROD, February 1997) satisfies the DOE commitment made in the *Disposal of Hanford Defense High-Level, Transuranic and Tank Waste Final Environmental Impact Statement* (DOE/EIS-0113, December 1987; RODs, March and April 1988) to prepare a supplemental NEPA analysis. The TWRS EIS was prepared in response to several important changes subsequent to the ROD, including a revised strategy for managing and disposing of tank waste and encapsulated cesium and strontium. The TWRS EIS evaluates, as a part of the proposed action: continued operation and management of the tank farms; waste transfer system upgrades; and retrieval and treatment of the tank waste, which would include the construction and operation of a facility to vitrify HLW and vitrify or similarly immobilize the low-activity waste. DOE decided to implement the preferred alternative for retrieval, treatment, and disposal of tank waste and to defer a decision on the disposition of cesium and strontium capsules. Two supplement analyses to the EIS were prepared for the TWRS EIS. The first was the *Proposed Upgrades to the Tank Farm Ventilation, Instrumentation, and Electrical Systems under Project W-314 in Support of Tank Farm Restoration and Safe Operations* (DOE/EIS-0189-SA1, June 1997). Based on this supplement analysis, upgrades or planned upgrades to the tank farm do not pose any additional potential environmental impacts, and therefore no additional NEPA analysis is required. The second supplement analysis was for the *Tank Waste Remediation System* (DOE/EIS-0189-SA2, May 1998). The analysis provides information on the most recent inventory of chemical

and radiological constituents in the tanks and new waste that is to be sent to the tanks for treatment. Based on the new data, it was concluded that there would be minimal changes from the impacts identified in the TWRS EIS, and therefore, no additional NEPA analysis is required.

The *Plutonium Finishing Plant Stabilization Final Environmental Impact Statement* (DOE/EIS-0244F, May 1996; ROD, July 1996) analyzes the potential environmental impacts of alternative approaches to: (1) stabilization of residual plutonium-bearing materials at the Hanford Plutonium Finishing Plant (PFP) to a form suitable for long-term storage; (2) removal of readily retrievable plutonium-bearing materials left behind in process equipment, process areas, and air quality and liquid waste management systems as a result of historic uses; and (3) interim storage of stabilized fissile material in existing PFP vaults pending decisions on ultimate storage and disposition of the material. DOE decided to remove readily retrievable plutonium-bearing materials in holdup at PFP. Following their stabilization, plutonium-bearing materials will be in a form suitable for interim storage in existing vaults at PFP. These materials are included in the plutonium inventory addressed in this SPD EIS. Other plutonium-bearing material having low plutonium content (less than 50 percent by weight) and meeting criteria established by DOE may be treated at PFP using a cementation process.

The *Final Hanford Remedial Action Environmental Impact Statement and Comprehensive Land Use Plan*, (DOE/EIS-0222-F, September 1999) revises the scope of the EIS and alternatives in response to comments received on the original draft. The final EIS focuses on developing an overall strategy for future land use at Hanford and includes a proposed comprehensive land-use plan. The preferred alternative is to consolidate waste management operations in the Central Plateau, allow industrial development in the eastern and southern portions of the site, increase recreational access to the Columbia River, and expand Saddle Mountain National Refuge to include all of the Wahluke Slope, McGee Ranch, and Fitzner-Eberhardt Arid Lands Ecology Reserve.

The *Hanford Reach of the Columbia River Comprehensive River Conservation Study and Environmental Impact Statement* (Final, June 1994, National Park Service) evaluates protecting the Hanford Reach of the Columbia River in terms of its designation as a Wild and Scenic River, provisions for recreation access, and visitor interpretation and education.

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, April 1995; ROD, May 1995) is a complex-wide evaluation of alternatives for managing, through the year 2035, existing and reasonably foreseeable amounts of spent nuclear fuel within the DOE inventory. The EIS contains an analysis of the transportation of spent nuclear fuel, as well as sitewide alternatives for environmental restoration and waste management programs at the Idaho National Engineering Laboratory (INEL, now INEEL). The ROD designated Hanford, INEEL, and SRS for regional spent fuel storage and management, and made decisions for environmental restoration and waste management at INEEL. In March 1996, DOE issued an amendment to the May 1995 ROD to include a decision to regionalize the management of DOE-owned spent nuclear fuel by fuel type, including spent fuel currently stored at Hanford, INEEL, and SRS.

The *Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel* (DOE/EIS-0218F, February 1996; ROD, July 1996) evaluates the adoption of a joint DOE/Department of State policy to manage spent nuclear fuel from foreign research reactors, including HEU provided by the United States to other countries for research reactors. Management alternatives include a number of implementation options for port selection, transportation, and storage at DOE sites. The ROD selected a management policy that provided for the return to the United States of spent fuels from various research reactors, using two designated U.S. ports, and the management at INEEL and SRS. A supplement analysis (DOE/EIS-0218-SA-2, August 1998) was prepared to examine acceptance of foreign research reactor spent nuclear fuel under three scenarios not specifically examined in the EIS: (1)

accepting spent fuel not included in EIS-estimated inventories, (2) accepting spent fuel from countries in quantities greater than those identified in the EIS, and (3) transporting more than eight casks of spent fuel on a single ocean-going vessel. The supplement analysis concluded that the potential environmental impacts of these actions are bounded by the analysis performed in the EIS and, therefore, no supplement to the EIS need be prepared.

The DOE INEEL *Advanced Mixed Waste Treatment Project Final Environmental Impact Statement* (DOE/EIS-0290, January 1999; ROD, April 1999) evaluates four alternatives: (1) No Action Alternative under which existing waste management operations, facilities, and projects would continue; (2) the proposed action/preferred alternative under which BNFL, Inc., would build and operate an Advanced Mixed Waste Treatment Project (AMWTP) facility using proposed thermal and nonthermal treatment technologies for certification and shipment to WIPP or another acceptable disposal facility; (3) nonthermal treatment alternative under which some treatment of transuranic, alpha low-level mixed, and low-level mixed wastes would occur at an AMWTP facility at the same location as the proposed action, and wastes that require thermal treatment would be repackaged for storage; and (4) treatment and storage alternative, which would include the same processes as the proposed action/preferred alternative except treated waste would be placed in Resource Conservation and Recovery Act–permitted storage units at the onsite Radioactive Waste Management Complex for long-term storage. In the ROD, DOE selected the preferred alternative.

The *Final Environmental Impact Statement and Environmental Impact Report for Continued Operation of Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore* (DOE/EIS-0157, August 1992; ROD, January 27, 1993) evaluates the proposed action of ongoing and proposed facilities and activities at LLNL and Sandia National Laboratories, including near-term (within 5 to 10 years) proposed projects. Three other alternatives analyzed include no action, modification of operations, and shutdown and decommissioning. This EIS updates the sitewide EIS issued in 1982. A decision was made in the ROD to continue operations as outlined in the proposed action. A supplement analysis (DOE/EIS-0157-SA-01, March 1999) was prepared to examine current project and program plans and proposals for operations and identify new or modified projects or operations for the period 1998 to 2002 that were not considered in the 1992 EIS. The supplement analysis concluded that either the projected impacts are within the bounds of the 1992 EIS, the impacts were anticipated by mitigation measures established in the 1992 EIS, or the incremental differences in impacts are not significant; therefore, no supplementation to the 1992 EIS is needed.

The *Site-Wide Environmental Impact Statement for the Continued Operation of the Los Alamos National Laboratory* (DOE/EIS-0238, January 1999; ROD, September 1999) evaluates ongoing and reasonably foreseeable new operations and facilities at LANL in support of DOE missions. This sitewide EIS updates the LANL sitewide EIS issued in 1979. Currently, small-scale R&D activities related to pit disassembly and conversion and MOX fuel fabrication are being conducted at LANL. Chapter 1, Section 1.8, of the sitewide EIS describes the SPD EIS as a related NEPA document. A description of the proposed MOX fuel lead assembly fabrication is included in Chapter 2, Background on Los Alamos National Laboratory Facilities and Activities, in Sections 2.2.2.2 and 2.2.2.15. Impacts of MOX fuel lead assembly fabrication are included in the cumulative impacts section of the LANL sitewide EIS, Sections 5.6.1.3, 5.6.1.7, 5.6.1.8, and 5.6.1.9. A decision was made in the LANL ROD to implement the preferred alternative, which includes expansion of operations, as the need arises, an increase in the level of existing operations to the highest reasonably foreseeable levels, and full implementation of the mission elements assigned to LANL.

The *Final Environmental Impact Statement for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components* (DOE/EIS-0225, November 1996; ROD, January 1997) evaluates all current and proposed facilities and activities at Pantex, including weapons dismantlement and storage of the resulting nuclear materials and classified weapons components in the near term (over a 5- to 10-year period). This sitewide EIS addresses alternative interim storage sites for Pantex plutonium pits, some of which will

ultimately be disposed of as determined in this SPD EIS. A supplement analysis to the Pantex EIS was issued, *Supplement Analysis for: Final Environmental Impact Statement for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components—AL–R8 Sealed Insert Container* (August 1998), to determine the potential impacts associated with repackaging pits into AL–R8 SI containers as opposed to the AT–400A container originally considered. The analysis concluded that the AL–R8 SI met the requirements that were established in the EIS for pit storage at Pantex and that no further NEPA documentation would be required. However, the seals in the AL–R8 SI containers must be changed after 30 years of storage,[29] and the pit-holding fixture in many of the AL–R8 SI containers must be modified. New shipping containers are also required to augment the limited number of existing shipping containers.

The *Final Environmental Impact Statement, Construction and Operation of the Spallation Neutron Source* (DOE/EIS-0247, April 1999; ROD, June 1999) analyzes the potential environmental impacts of constructing and operating a state-of-the-art Spallation Neutron Source facility at one of four sites: ORNL (preferred alternative); Argonne National Laboratory in Argonne, Illinois; Brookhaven National Laboratory in Upton, New York; and LANL. The ROD designated ORNL as the chosen site for the facility.

The *Final Environmental Assessment for Wastewater Treatment Capability Upgrade* (DOE/EA-1190, April 1999; FONSI, May 27, 1999) analyzes a proposed action to design, build, and operate a new wastewater treatment facility at Pantex.

The *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management* (DOE/EIS-0236, September 1996; ROD, December 1996) evaluates the potential environmental impacts resulting from activities associated with nuclear weapons research, design, development, and testing, as well as the assessment and certification of their safety and reliability. The stewardship portion of the document analyzes the development of three new facilities to provide enhanced experimental capabilities. The stockpile management portion of the EIS concerns producing, maintaining, monitoring, refurbishing, and dismantling the nuclear weapons stockpile at eight sites, including Pantex and SRS. A decision was made in the ROD to downsize a number of facilities for stockpile dismantlement, and to build experimental facilities at LLNL. A draft supplement analysis (DOE/EIS-0236-SA6, June 1999) was prepared to examine the plausibility of a building-wide fire at LANL's plutonium facility and to look at new studies regarding seismic hazards at LANL. The draft supplement analysis was issued for public comment, and a final supplement analysis was issued on September 2, 1999. The supplement analysis concluded that there is no need to prepare a supplemental EIS.

The *Final Environmental Impact Statement, Interim Management of Nuclear Materials* (DOE/EIS-0220, October 1995) analyzes the potential environmental impacts of the management of certain nuclear materials at SRS pending decisions on their future use or ultimate disposition. The EIS includes an analysis of the construction of the SRS Actinide Packaging and Storage Facility. Five RODs have been issued since the Final EIS was published. On December 12, 1995, DOE issued a ROD and Notice of Preferred Alternatives (60 FR 65300) on the interim management of several categories of nuclear materials at SRS. DOE decided to stabilize plutonium and uranium stored in vaults using a combination of management methods. On February 8, 1996, DOE issued a supplemental ROD (61 FR 6633) on the stabilization of two of the remaining categories of nuclear materials (Mark-16 and Mark-22 fuels and other aluminum-clad targets) analyzed in the Final EIS. After considering a DOE staff study and recommendation on canyon facility utilization, DOE issued a second supplemental ROD on September 6, 1996 (61 FR 48474) for stabilization of the neptunium 237 solutions, obsolete neptunium targets, and plutonium 239 solutions. On April 2, 1997, DOE issued a third supplemental ROD (62 FR 17790) on stabilization in the F-Canyon and FB-Line facilities of the remaining

[29] This means that the undisturbed storage period changes from 50 to 30 years. See Section 1.7.4 for additional details on the effect of the AL–R8 SI decision on the surplus plutonium disposition program.

Taiwan Research Reactor spent nuclear fuel. In October 1997, DOE issued a fourth supplemental ROD to add an additional method, processing and storage for vitrification in DWPF, to those being used in the management of plutonium and uranium stored in vaults; and to amend its September 6, 1996, ROD to provide for use of the H-Canyon facilities to stabilize, to oxide forms, the plutonium 239 and neptunium 237 solutions stored in H-Canyon and obsolete neptunium 237 targets stored in K-Reactor.

The *Savannah River Site Waste Management Final Environmental Impact Statement* (DOE/EIS-0217, July 1995; ROD, September 1995) analyzes future SRS waste management needs for all waste types over the next 30 years, including the treatment, storage, and disposal of high-level, low-level, mixed, hazardous, and TRU wastes generated from environmental restoration, facility operations, and D&D of buildings. In the ROD, DOE selected phased approaches to waste treatment, storage, and disposal facilities identified in the Final EIS.

The *Spent Nuclear Fuel Management Draft Environmental Impact Statement* (DOE/EIS-0279D, December 1998) evaluates processes for the safe and efficient management of spent nuclear fuel and targets at SRS, including placing these materials in forms suitable for ultimate disposition. Alternatives analyzed include new packaging, new processing, and conventional processing technologies, as well as the No Action Alternative. The preferred alternative for 97 percent of the volume is to use a melt and dilute treatment process. The remaining 3 percent would be managed using conventional processing.

The *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement* (DOE/EIS-0240, June 1996; ROD, July 1996) addresses the disposition of a nominal 200 t (220 tons) of HEU declared surplus to the national security needs of the United States. Alternatives include several approaches to blending down the highly enriched material to make it nonweapons usable and suitable for fabrication into fuel for commercial nuclear reactors. The ROD calls for blending, over time, as much material as possible (up to 85 percent) for commercial use, and blending the remainder for disposal as LLW. Blending sites include SRS.

The *F-Canyon Plutonium Solutions at Savannah River Site Final Environmental Impact Statement* (DOE/EIS-0219, December 1994; ROD, February 1995) evaluates alternatives to stabilize plutonium solutions currently stored in F-Canyon at SRS before their disposition as determined in this SPD EIS. The alternatives examined are taking no action, processing the solutions to plutonium metal, processing the solutions to plutonium dioxide, and transferring the solutions to the HLW tanks for vitrification in DWPF. DOE has processed the plutonium solutions to a metal form using the F-Canyon and FB-Line facilities at SRS.

The *Final Supplemental Environmental Impact Statement, Defense Waste Processing Facility* (DOE/EIS-0082-S, November 1994; ROD, April 1995) assesses the environmental impacts of the construction and operation of DWPF at SRS as modified from the original design addressed in a 1982 EIS. DWPF includes the HLW pretreatment process, the vitrification facility, facilities for the manufacture and disposal of saltstone (LLW resulting from the pretreatment of HLW), radioactive glass waste storage facilities, and associated support facilities. DOE is currently preparing a second supplement, which was announced in the Federal Register on February 22, 1999 (64 FR 8558), on the proposed replacement of the In-Tank Precipitation (ITP) process at SRS. The ITP process as presently configured cannot achieve production goals and safety requirements. Three alternative processes are being evaluated: small tank precipitation, ion exchange, and direct grout. Because replacement of the ITP process constitutes a substantial change to the operation of DWPF as evaluated in the *1994 Supplemental EIS*, DOE is preparing a second supplemental EIS that addresses the potential environmental impacts of ITP process alternatives. DOE's preferred immobilization technology (can-in-canister) and immobilization site (SRS) are dependent on DWPF providing vitrified HLW with sufficient radioactivity.

The *Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling* (DOE/EIS-0161, October 1995; ROD, December 5, 1995) evaluates the siting, construction, and operation of tritium supply technology alternatives and recycling facilities at five candidate sites, as well as the use of a commercial reactor

for producing tritium. The ROD determined that a dual-track approach would be used. One track explores the purchase of an operating or partially complete commercial light water reactor or the purchase of irradiation services from such a reactor. The second track would design, build, and test critical components of an accelerator system for production of tritium. The ROD states that DOE would select one of the alternatives at a later date to serve as the primary source of tritium for the nuclear weapons stockpile, with the other alternative developed as a back-up source, if feasible. SRS was selected as the location for the accelerator. (See Consolidated ROD discussion below.)

The *Final Environmental Impact Statement for Accelerator Production of Tritium at the Savannah River Site* (DOE/EIS-0270, March 1999; Consolidated ROD, May 1999) evaluates the siting, construction, and operation of a linear accelerator at SRS that would produce tritium, a gaseous radioactive isotope of hydrogen considered essential to the operation of U.S. thermonuclear weapons. DOE issued a Consolidated ROD that made the following decisions: (1) the use of commercial light water reactors is the primary source of tritium supply; (2) the accelerator at SRS is the backup tritium supply source, but will not be constructed; (3) the Tennessee Valley Authority's Watts Bar Unit 1 and Sequoyah Unit 1 and 2 reactors are the specific reactors that will provide irradiation services for tritium supply; (4) the H-Area location at SRS is the location for a new tritium extraction facility; and (5) the location and various technologies required to develop the accelerator as a backup to the commercial light water reactors are identified.

The *Final Environmental Impact Statement for the Production of Tritium in a Commercial Light Water Reactor* (DOE/EIS-0288, March 4, 1999; Consolidated ROD, May 1999) evaluates the production of tritium at one or more of five commercial light water reactors, including the transportation of irradiated tritium-producing burnable absorber rods from the reactors to the proposed tritium extraction facility at SRS. (See Consolidated ROD discussion above.)

The *Final Environmental Impact Statement for Construction and Operation of a Tritium Extraction Facility at the Savannah River Site* (DOE/EIS-0271, March 1999; Consolidated ROD, May 1999) evaluates the construction and operation of a facility for the extraction of tritium to support the DOE tritium production capability. (See Consolidated ROD discussion above.)

The *Final Environmental Impact Statement for Shutdown of the River Water System at Savannah River Site* (DOE/EIS-268, May 1997; ROD, January 1998) evaluates the shutdown of the River Water System used to pump large quantities of water from the Savannah River for cooling purposes within SRS. Alternatives for placing all or part of the system in standby mode are also considered. The ROD selected the No Action Alternative, that is, continuing the maintenance and operation of the Savannah River Water System for the foreseeable future.

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; FONSI, September 1995) analyzes the continued receipt, prestorage processing, and interim storage of enriched uranium in quantities that would exceed the historic maximum storage level. On the basis of this EA, DOE determined that Y–12 would store no more than 500 t (551 tons) of HEU and no more than 6 t (6.6 tons) of LEU. HEU recovered from the SPD EIS pit conversion facility would be shipped to Y–12 for interim storage pending disposition.

The *Notice of Intent to Prepare a Site-Wide Environmental Impact Statement for the Oak Ridge Y–12 Plant* (64 FR 13179) was published March 17, 1999. The EIS will analyze current levels of Y–12 operations and foreseeable new operations and facilities for approximately the next 10 years. The EIS will also provide a baseline of impacts associated with current activities, analyze the potential impacts of constructing a new enriched uranium storage facility, and address siting issues associated with other possible modernization projects. HEU

received from the pit conversion facility would be shipped to Y–12 for interim storage pending disposition. HEU storage at Y–12 could be affected by decisions made in the EIS.

1.8.4 Cooperating Agencies

In May 1997, DOE notified several agencies, including NRC and the U.S. Environmental Protection Agency (EPA), that this SPD EIS was being prepared. On November 10, 1997, NRC informed DOE that it would be a "commenting" rather than "cooperating" agency.[30] In keeping with this decision, DOE provided copies of the SPD Draft and Final EIS and *Supplement* to NRC for comment. No agencies other than EPA have decided to be a cooperating agency for this SPD EIS.

1.9 ORGANIZATION OF THIS SPD EIS

This SPD EIS consists of three volumes. Volume I contains the main text of the EIS. Volume II contains technical appendixes that provide supporting details for the analyses in Volume I, as well as additional project information. Volume III contains the comments received on the Draft EIS during the public review periods, along with the DOE responses to these comments. An EIS Summary is also available.

Volume I consists of Chapters 1 through 9. Chapter 2 describes the surplus plutonium disposition alternatives, how the alternatives were developed, and the proposed types of disposition facilities. It also provides a comparison of the alternatives. Chapter 3 describes the potentially affected environments at the candidate sites. Chapter 4 provides summary descriptions of the potential impacts of the proposed action and alternatives on 13 resource areas. This chapter also describes cumulative impacts, D&D and deactivation and stabilization, irreversible and irretrievable commitments of resources, and the relationship between short-term uses of the environment and long-term productivity. Chapter 5 provides a description of the environmental and health and safety compliance requirements governing implementation of the alternatives and includes the status of required consultations with Federal, State, and local agencies. References are included at the end of each chapter. Chapters 6, 7, 8, and 9 are the glossary of terms, the list of SPD EIS preparers, the SPD EIS distribution list, and the index, respectively.

Volumes II and III provide information that supports Volume I. Volume II consists of 16 appendixes and includes background documents, process descriptions, facility data, descriptions of methods used to estimate environmental impacts of the alternatives, and the detailed impact analysis. Volume III includes the comments received on the SPD Draft EIS and the *Supplement*, the responses to the comments, and a brief summary of changes made to the SPD Draft EIS and the *Supplement* in response to the comments.

1.10 REFERENCES

DOE (U.S. Department of Energy), 1996a, *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement*, DOE/EIS-0229, Office of Fissile Materials Disposition, Washington, DC, December.

DOE (U.S. Department of Energy), 1996b, *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement*, DOE/EIS-0240, Office of Fissile Materials Disposition, Washington, DC, June.

[30] A cooperating agency participates in the NEPA process at the request of the lead agency developing an EIS. The cooperating agency is involved in the scoping process and may develop information and prepare environmental analyses in its area of special expertise and make available staff support to the lead agency (40 CFR 1501.6, *Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act).* The lead agency may also request other agencies to comment on a draft EIS (40 CFR 1503.1).

DOE (U.S. Department of Energy), 1996c, *Record of Decision for the Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement*, 61 FR 40619, Office of the Federal Register, Washington, DC, August 5.

DOE (U.S. Department of Energy), 1997a, *Record of Decision for the Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement*, 62 FR 3014, Office of the Federal Register, Washington, DC, January 14.

DOE (U.S. Department of Energy), 1997b, *Notice of Intent to Prepare a Surplus Plutonium Disposition Environmental Impact Statement*, 62 FR 28009, Office of the Federal Register, Washington, DC, May 22.

DOE (U.S. Department of Energy), 1998a, *Cost Analysis in Support of Site Selection for Surplus Weapons-Usable Plutonium Disposition*, rev. 0, DOE/MD-0009, Office of Fissile Materials Disposition, Washington, DC, July 22.

DOE (U.S. Department of Energy), 1998b, *Pit Disassembly and Conversion Demonstration Environmental Assessment and Research and Development Activities*, DOE/EA-1207, Office of Fissile Materials Disposition, Washington, DC, August.

DOE (U.S. Department of Energy), 1998c, *Supplement Analysis for: Final Environmental Impact Statement for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components—AL–R8 Sealed Insert Container*, Albuquerque Operations Office, Amarillo Office, Amarillo, TX, August.

DOE (U.S. Department of Energy), 1999a, *Environmental Assessment for the Parallex Project Fuel Manufacture and Shipment*, DOE/EA-1216, Office of Fissile Materials Disposition, Washington, DC, January.

DOE (U.S. Department of Energy), 1999b, *Plutonium Disposition Life-Cycle Costs and Cost-Related Comment Resolution Document*, MD-0013, Office of Fissile Materials Disposition, Washington, DC, November.

DOE (U.S. Department of Energy), 1999c, *Draft Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, DOE/EIS-0250D, Office of Civilian Radioactive Waste Management, North Las Vegas, NV, July.

Paperiello, C.J., 1999, U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, Washington, DC, personal communication (letter) to L. Barrett, U.S. Department of Energy, Office of Civilian Radioactive Waste Management, Washington, DC, *U.S. Department of Energy Plans for Disposal of Surplus Weapons Plutonium*, January 25.

White, V.S., 1997, *Initial Data Report in Response to the Surplus Plutonium Disposition Environmental Impact Statement Data Call for the UO_2 Supply*, rev. 1, ORNL/TM-13466, Lockheed Martin Energy Research Corporation, Oak Ridge, TN, November.

White House, 1993, *Nonproliferation and Export Control Policy*, Office of the Press Secretary, Washington, DC, September 27.

White House, 1994, *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*, Office of the Press Secretary, Washington, DC, January 14.

Chapter 2
Alternatives for Disposition of Surplus Weapons-Usable Plutonium

2.1 ALTERNATIVES ANALYZED IN THIS SPD EIS

This *Surplus Plutonium Disposition Environmental Impact Statement* (SPD EIS) analyzes the potential environmental impacts associated with implementing the disassembly of pits (a component of nuclear weapons) and conversion of the recovered plutonium and clean plutonium metal at four candidate U.S. Department of Energy (DOE) sites; conversion and immobilization of plutonium from nonpit sources at two candidate DOE sites; and mixed oxide (MOX) fuel fabrication activities at four candidate DOE sites. This SPD EIS also evaluates immobilizing plutonium in ceramic or glass forms, and compares the can-in-canister approach with the homogenous ceramic immobilization and vitrification approaches that were evaluated in the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement (Storage and Disposition PEIS)* (DOE 1996a). As part of the MOX option, this SPD EIS also evaluates the potential impacts of fabricating MOX fuel lead assemblies (for test irradiation in domestic, commercial nuclear power reactors) at five candidate DOE sites, subsequent postirradiation examination of the lead assemblies at two candidate DOE sites, and addresses the impacts of irradiating MOX fuel in domestic, commercial reactors. Figure 2–1 is a map of the United States that identifies the proposed locations of the surplus plutonium disposition facilities.

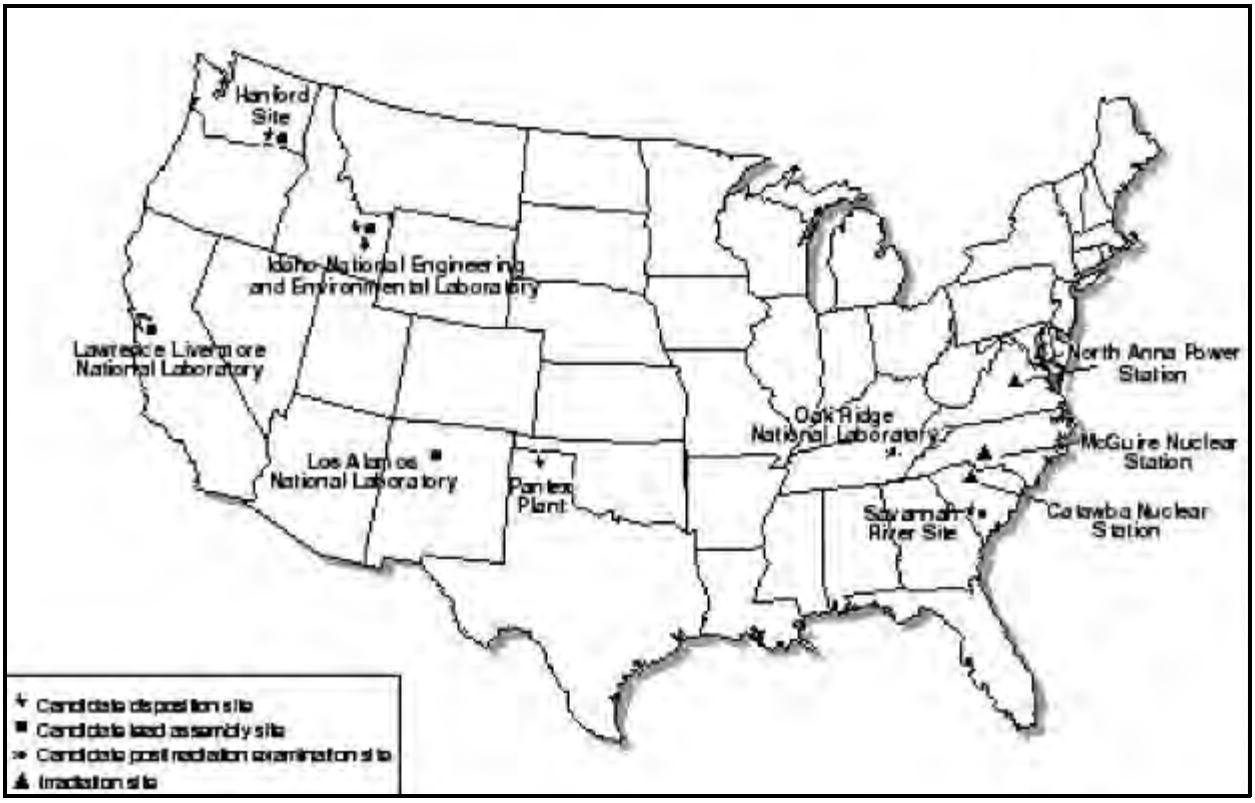


Figure 2–1. Proposed Locations of Surplus Plutonium Disposition Facilities

2.1.1 Surplus Plutonium Disposition Facility Alternatives

The alternatives analyzed in this SPD EIS are based on decisions announced in the Record of Decision (ROD) for the *Storage and Disposition PEIS,* as summarized in Chapter 1. Those decisions include:

- Combining the plutonium conversion and immobilization functions into a single facility,
- Pursuing the siting of a pit disassembly and conversion facility (pit conversion facility), a plutonium conversion and immobilization facility (immobilization facility), and a MOX fuel fabrication facility (MOX facility), and
- Reducing the number of possible disposition sites to be considered from six to four.

Fifteen surplus plutonium disposition alternatives and the No Action Alternative are shown in Table 2–1 and described in detail in Sections 2.5 through 2.16. The 15 action alternatives are organized into 11 sets of alternatives, reflecting various combinations of facilities and candidate sites, as well as the use of new or existing buildings. For example, Alternative 6, which would locate the pit conversion and MOX facilities at the Hanford Site (Hanford), and the immobilization facility at the Savannah River Site (SRS), has two variations, denoted as 6A and 6B. The variations occur because the MOX facility could be in new construction or in the Fuel and Materials Examination Facility (FMEF) at Hanford.

Each of the 15 alternatives includes a pit conversion facility, but additional facilities in each alternative vary depending on the amount of plutonium to be immobilized. Alternatives 2 through 10 involve the hybrid approach of immobilizing 17 t (19 tons) of surplus plutonium and using 33 t (36 tons) for MOX fuel, and therefore, require all three facilities. Alternatives 11 and 12 involve immobilizing all 50 t (55 tons), and therefore, only include a pit conversion facility and an immobilization facility.

Alternative 1, the No Action Alternative, does not involve disposition of surplus weapons-usable plutonium, but instead addresses continued storage of the plutonium in accordance with the *Storage and Disposition PEIS* ROD (DOE 1997a) and amended ROD (DOE 1998a).[1] Figures 2–2, 2–3, 2–4, and 2–5 are regional maps of the four candidate disposition sites: Hanford, Idaho National Engineering and Environmental Laboratory (INEEL), the Pantex Plant (Pantex), and SRS.

2.1.2 Immobilization Technology Alternatives

The *Storage and Disposition PEIS* discusses several immobilization technologies, including the homogenous ceramic and vitrification alternatives that were evaluated in detail, as well as the variants to those alternatives, which included the ceramic and glass can-in-canister approaches and another homogenous approach using an adjunct melter (discussed further in Appendix C of this SPD EIS). The ROD for the *Storage and Disposition PEIS* states that DOE would make a determination on the specific technology on the basis of "the follow-on EIS." This SPD EIS is that follow-on EIS, and identifies the ceramic can-in-canister approach as the preferred immobilization technology.

In order to bound the estimate of potential environmental impacts associated with ceramic and glass immobilization technologies, the *Storage and Disposition PEIS* analyzes the construction and operation of

[1] Should the No Action Alternative be chosen, the ROD pursuant to this SPD EIS would also address the movement of the remaining surplus nonpit plutonium from RFETS in support of its planned closure in 2006.

vitrification and ceramic immobilization facilities that use a homogenous approach. These facilities are based on generic designs that do not involve the use of existing facilities or specific site locations. These generic designs allow for surplus plutonium to be immobilized in a homogenous form, either within a ceramic matrix and formed into disks, or vitrified as borosilicate glass logs.

Table 2–1. Surplus Plutonium Disposition Facility Alternatives Evaluated in This SPD EIS

Alternative	Pit Disassembly and Conversion	Plutonium Conversion and Immobilization	MOX Fuel Fabrication	Disposition Amounts (Plutonium)
1	**No Action**			
2	Hanford (FMEF)	Hanford (FMEF and HLWVF)	Hanford (New)	17 t Immobilization/ 33 t MOX
3	SRS (New)	SRS (New and DWPF)	SRS (New)	17 t Immobilization/ 33 t MOX
4A	Pantex (New)	Hanford (FMEF and HLWVF)	Hanford (New)	17 t Immobilization/ 33 t MOX
4B	Pantex (New)	Hanford (FMEF and HLWVF)	Hanford (FMEF)	17 t Immobilization/ 33 t MOX
5	Pantex (New)	SRS (New and DWPF)	SRS (New)	17 t Immobilization/ 33 t MOX
6A	Hanford (FMEF)	SRS (New and DWPF)	Hanford (New)	17 t Immobilization/ 33 t MOX
6B	Hanford (FMEF)	SRS (New and DWPF)	Hanford (FMEF)	17 t Immobilization/ 33 t MOX
7	INEEL (FPF)	SRS (New and DWPF)	INEEL (New)	17 t Immobilization/ 33 t MOX
8	INEEL (FPF)	Hanford (FMEF and HLWVF)	INEEL (New)	17 t Immobilization/ 33 t MOX
9	Pantex (New)	SRS (New and DWPF)	Pantex (New)	17 t Immobilization/ 33 t MOX
10	Pantex (New)	Hanford (FMEF and HLWVF)	Pantex (New)	17 t Immobilization/ 33 t MOX
11A	Hanford (FMEF)	Hanford (FMEF and HLWVF)	NA	50 t Immobilization/ 0 t MOX
11B	Pantex (New)	Hanford (FMEF and HLWVF)	NA	50 t Immobilization/ 0 t MOX
12A	SRS (New)	SRS (New and DWPF)	NA	50 t Immobilization/ 0 t MOX
12B	Pantex (New)	SRS (New and DWPF)	NA	50 t Immobilization/ 0 t MOX
[Text deleted.] Alternatives 3B, 5B, 6C, 6D, 7B, 9B, 12B, and 12D in the SPD Draft EIS have been deleted. Alternative 12C has been renumbered as 12B.[a]				

[a] Section 2.3.2.2 explains the deletion of these alternatives.

Key: DWPF, Defense Waste Processing Facility; FMEF, Fuels and Materials Examination Facility; FPF, Fuel Processing Facility; HLWVF, high-level-waste vitrification facility (planned); NA, not applicable.

In order to support a decision on the immobilization technology and form, this SPD EIS evaluates the potential environmental impacts of the ceramic and glass can-in-canister technologies, and compares those impacts with the impacts of the homogenous facilities evaluated in the *Storage and Disposition PEIS.* This comparison is presented in Section 4.29.

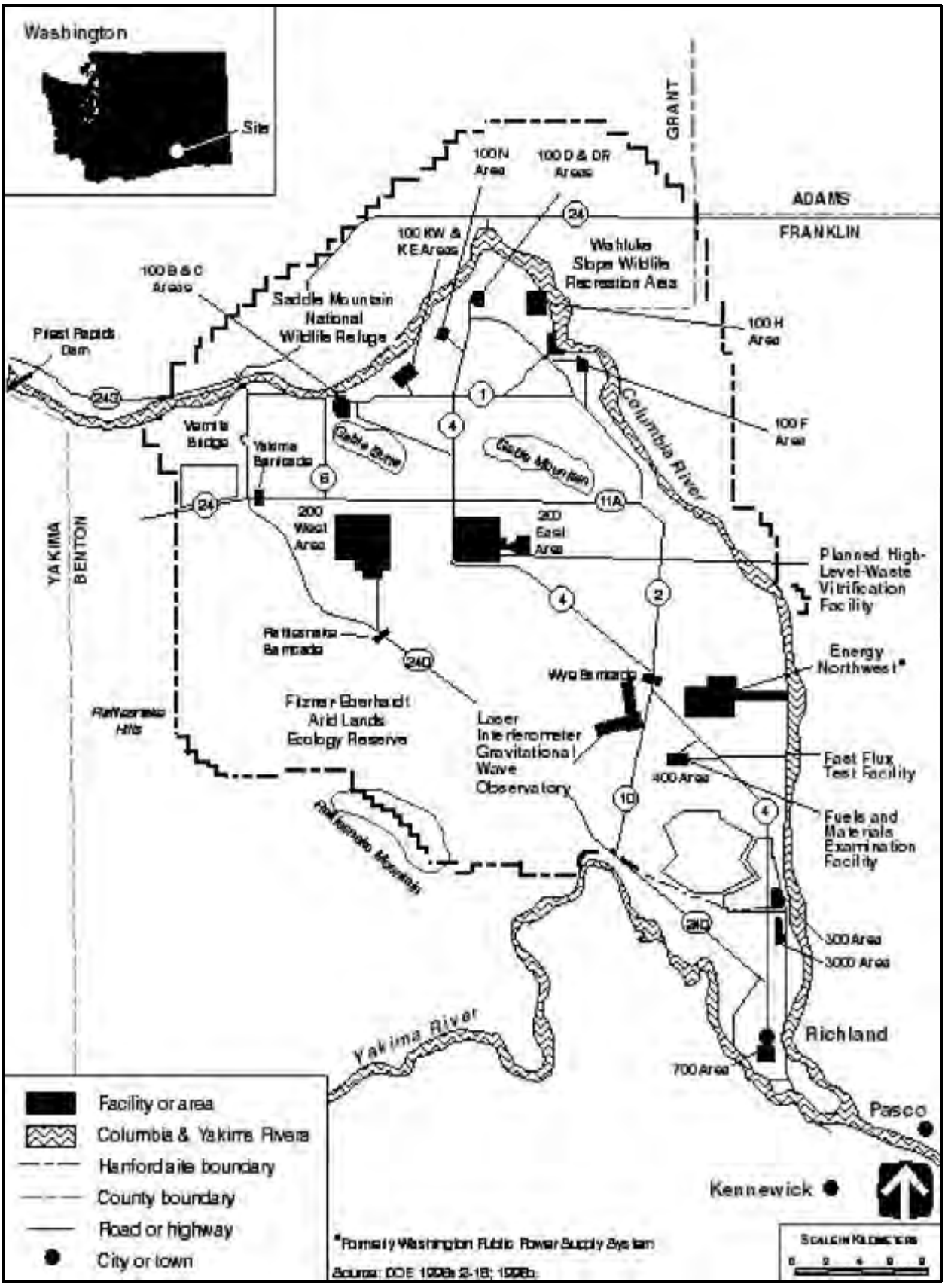


Figure 2–2. Hanford, Washington

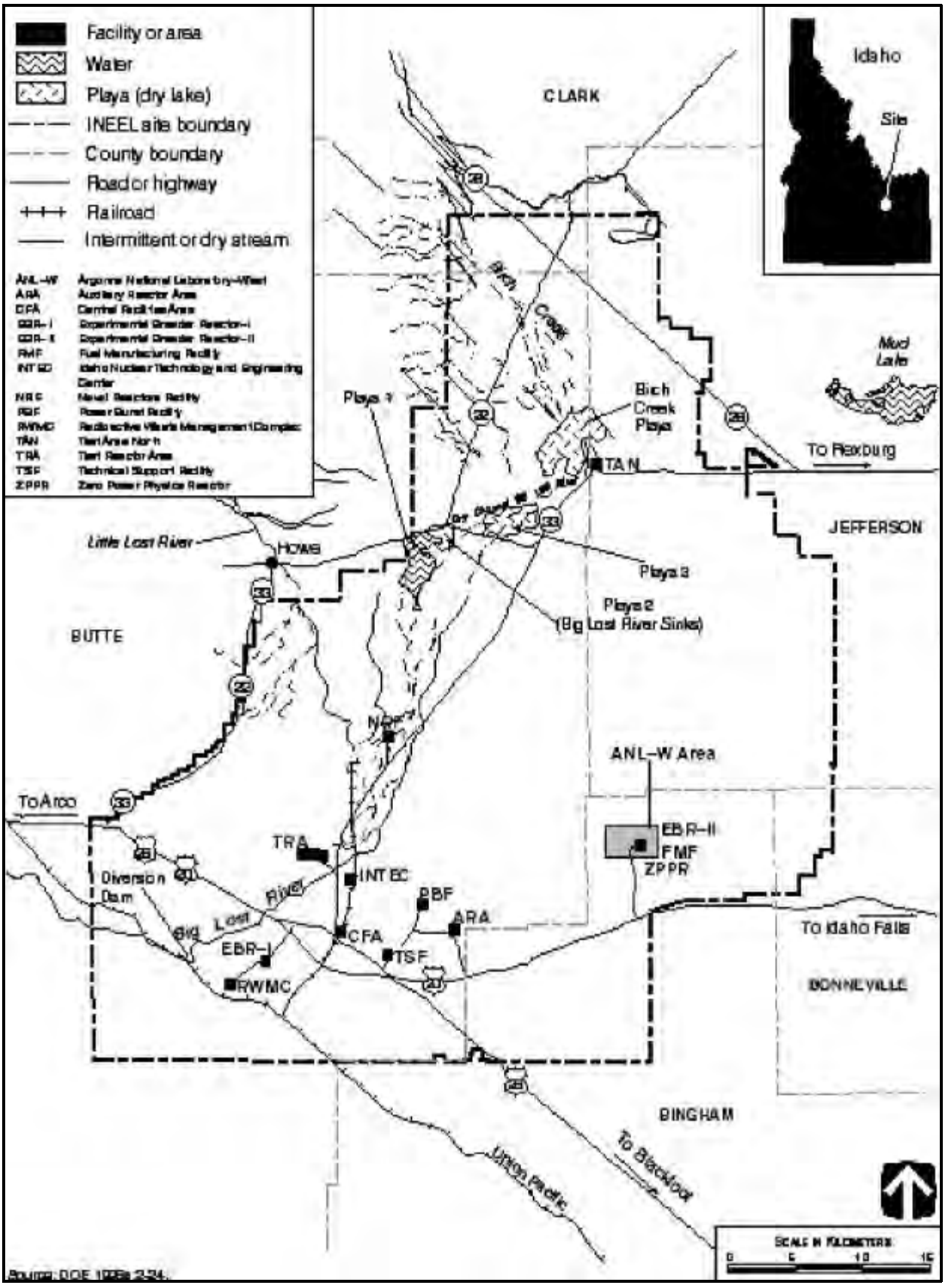


Figure 2–3. INEEL, Idaho

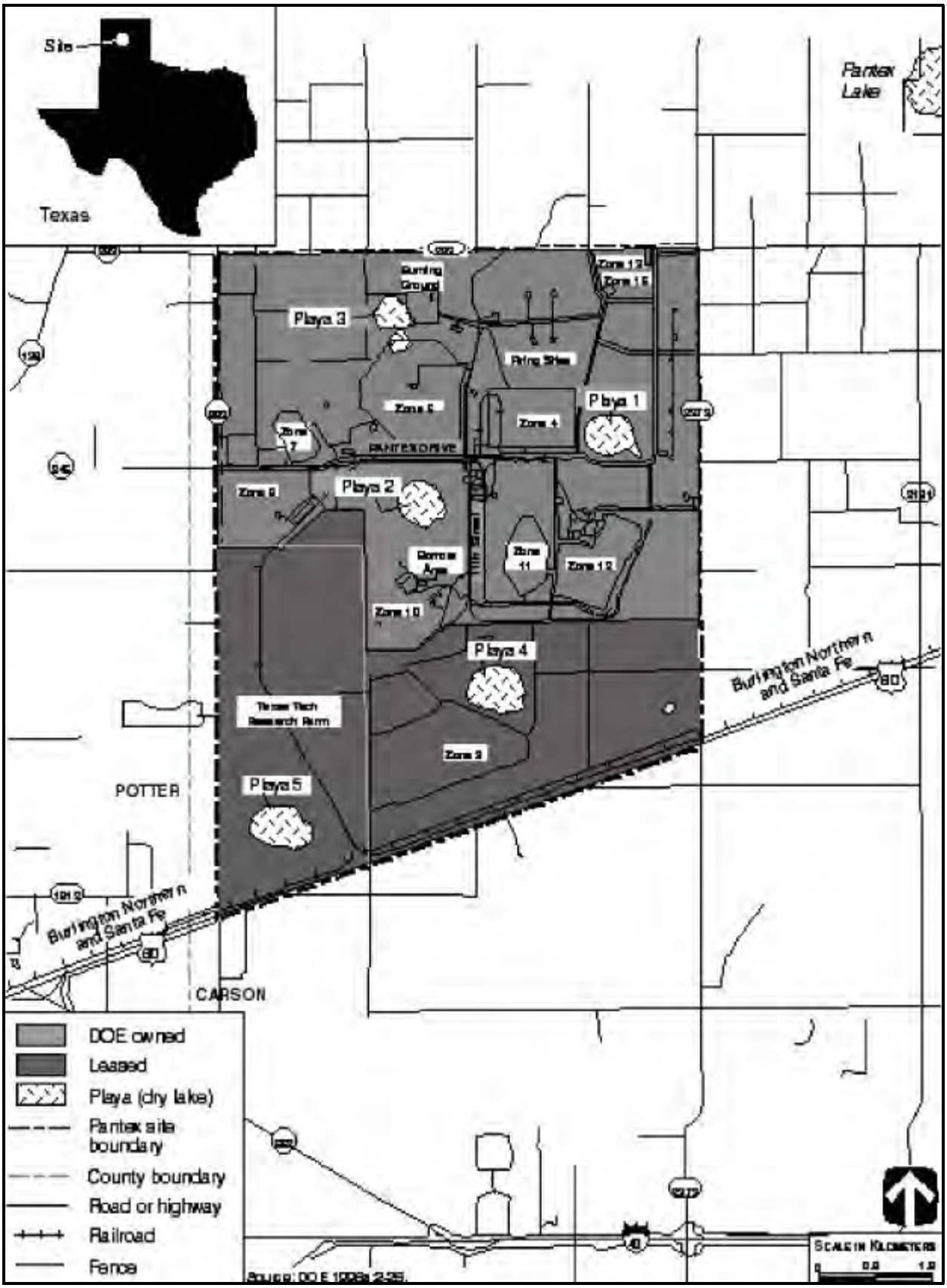


Figure 2–4. Pantex, Texas

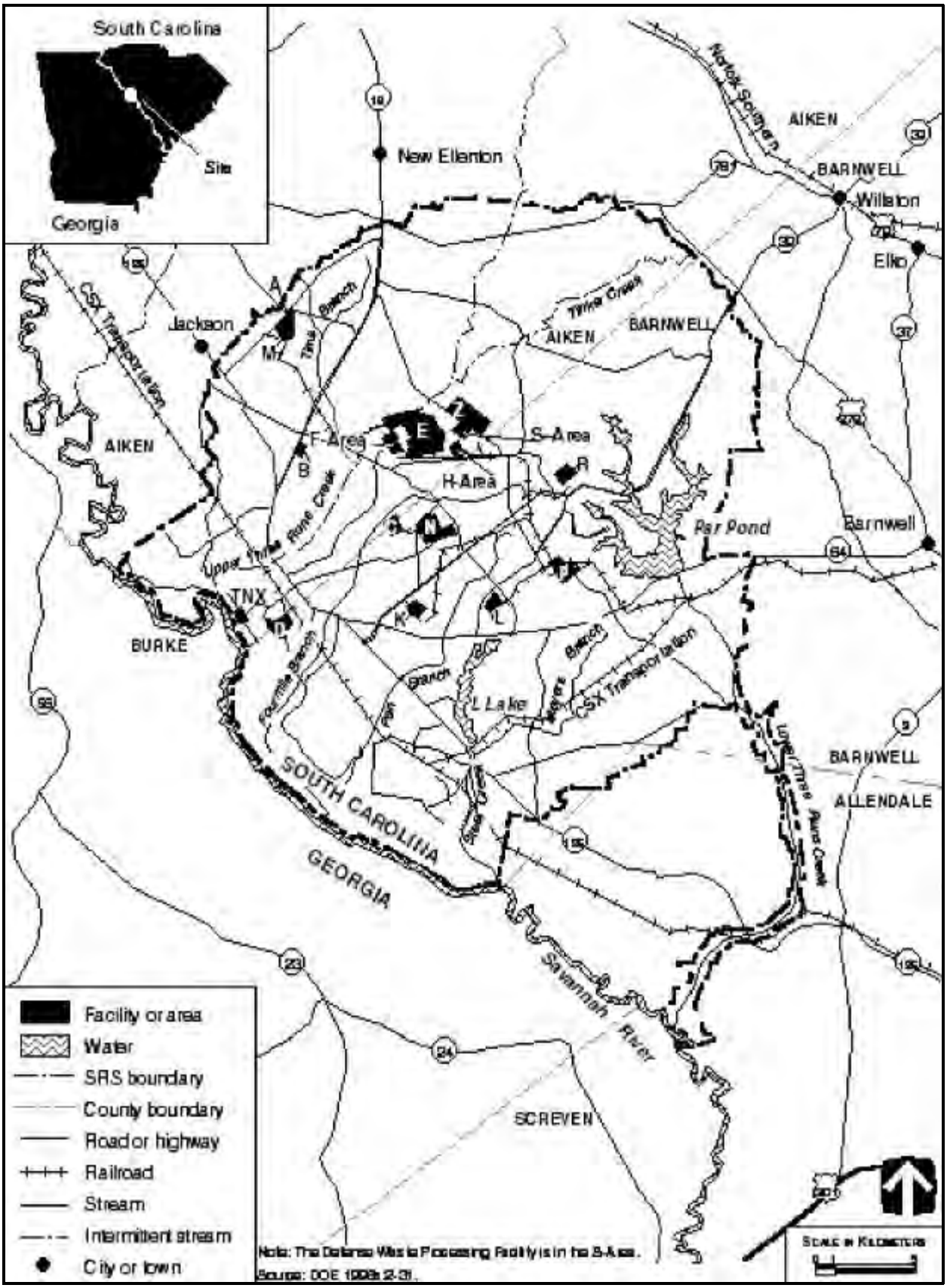


Figure 2–5. SRS, South Carolina

2.1.3 MOX Fuel Fabrication Alternatives

Alternatives that involve the manufacture of MOX fuel include the use of the fuel in existing domestic, commercial reactors. The environmental impacts of using MOX fuel in these reactors are evaluated generically in the *Storage and Disposition PEIS*. When the SPD Draft EIS was published, the specific reactors were not known; therefore, that generic analysis was incorporated by reference in the SPD Draft EIS, summarized in Section 4.28, and included in the discussion of the integrated impacts of the MOX fuel alternatives presented in Section 2.18.3. This was done with the understanding that by the time the SPD Final EIS would be published, the specific reactors would have been identified and reactor-specific analyses would replace the generic analysis.

[Text deleted.] In May 1998, DOE initiated a procurement process to obtain MOX fuel fabrication and irradiation services. The Request for Proposals (RFP) defined limited activities that may be performed prior to issuance of the SPD EIS ROD. These activities include non-site-specific work primarily associated with the development of the initial conceptual design for the fuel fabrication facility; and plans (paper studies) for outreach, long lead-time procurements, regulatory management, facility quality assurance, safeguards, security, fuel qualifications, and deactivation. In compliance with its National Environmental Policy Act (NEPA) regulations at 10 CFR 1021.216, DOE requested that each offeror provide, as part of its proposal, environmental information specific to its proposed MOX facility design and the domestic, commercial reactors proposed to be used for irradiation of the fuel. That information was analyzed by DOE to identify potential environmental impacts of the proposals and documented in an Environmental Critique prepared pursuant to 10 CFR 1021.216(g). That analysis was considered by the selection official as part of the award decision.

DOE awarded a contract to the team of Duke Engineering & Services, COGEMA Inc., and Stone & Webster (DCS) in March 1999 to provide the requested services. These services include design, licensing, construction, operation, and eventual deactivation of the MOX facility as well as irradiation of the MOX fuel in six domestic, commercial reactors at three sites. The reactors proposed by DCS are Duke Power Company's Catawba Nuclear Station, Units 1 and 2; McGuire Nuclear Station, Units 1 and 2; and Virginia Power Company's North Anna Power Station, Units 1 and 2. No facility construction or MOX fuel fabrication or irradiation of MOX fuel is to occur until the SPD EIS ROD is issued. Additionally, no MOX fuel is to be irradiated until NRC amends the operating license of each selected reactor prior to the specific reactor receiving the MOX fuel. Such site-specific activities, and DOE's exercise of contract options to allow those activities, would be contingent on decisions in the ROD.

As provided in 10 CFR 1021.216(h), an Environmental Synopsis (Synopsis), based on the Environmental Critique, was provided to

"216 Process"

DOE's NEPA Implementing Regulations (10 CFR Part 1021) include special provisions to enable a source selection official to consider, as part of the procurement decision, the environmental impacts of the offerors' proposals. As provided in 10 CFR 1021.216, DOE may require that offerors submit environmental data and analyses as a discrete part of the offeror's proposal. DOE will then:

- independently evaluate and verify the submitted information;
- prepare an environmental critique (subject to confidentiality requirements of the procurement process) for offers in the competitive range, addressing environmental issues pertinent to a decision on the proposals; and
- prepare a publicly available environmental synopsis, based on the environmental critique, to document consideration given to environmental factors in the selection process.

After a selection has been made, the environmental synopsis shall be filed with EPA, made publicly available, and incorporated in an EIS prepared for the action.

If the NEPA process is not completed before the award, the contracts shall be made contingent on completion of the NEPA process. DOE shall phase subsequent contract work to allow the NEPA review process to be completed in advance of a go/no-go decision.

the U.S. Environmental Protection Agency (EPA), made available to the public, and incorporated as Appendix P to this SPD EIS. In addition, Section 3.7 was added to describe the affected environment at the three reactor sites, Section 4.28 was revised to include the reactor-specific analyses, and the relevant sections of Chapters 2 and 4 were revised as necessary to incorporate information provided by DCS about the proposed MOX facility, where different from that presented in the SPD Draft EIS. Sections of this SPD EIS that were revised or added to include reactor-specific information, including the new Appendix P presenting the Synopsis, were also distributed as the *Supplement to the SPD Draft EIS*.[2] A Notice of Availability was published in the Federal Register on May 14, 1999 (EPA 1999), providing a 45-day public comment period on the *Supplement*. This *Supplement* was distributed to interested parties in the local communities surrounding the Catawba, McGuire, and North Anna reactor sites; stakeholders who received the SPD Draft EIS; and others as requested. Comments are addressed in Volume III, the Comment Response Document, and, where appropriate, revisions were made to this SPD EIS.

Under the hybrid alternatives, DOE could produce up to 10 MOX fuel assemblies for testing in domestic, commercial reactors before commencement of full-scale MOX fuel irradiation, although it is likely that only 2 lead assemblies would be needed.[3] These lead assemblies would be available for irradiation to support U.S. Nuclear Regulatory Commission (NRC) licensing and fuel qualification efforts. Potential impacts of MOX fuel lead assembly fabrication are analyzed for three of the candidate sites for MOX fuel fabrication (Hanford, Argonne National Laboratory–West [ANL–W] at INEEL, and SRS), and two additional sites, Los Alamos National Laboratory (LANL) in New Mexico, and Lawrence Livermore National Laboratory (LLNL) in California. Pantex was not considered for lead assembly fabrication because it does not currently have any facilities capable of MOX fuel fabrication. Postirradiation examination of the lead assemblies, if required to support NRC licensing activities, would be conducted. Two potential sites for postirradiation examination are discussed in this SPD EIS: ANL–W and Oak Ridge National Laboratory (ORNL). These two sites are currently the only sites that have the capability to conduct postirradiation examination activities without major modifications to facility and processing capabilities; only minor modifications for receipt of materials would be required. Other potential facilities, either within the DOE complex or in the commercial sector, would require significant modifications to meet expected requirements. As discussed in Section 1.6, DOE's preferred locations for lead assembly fabrication and postirradiation examination are LANL and ORNL, respectively.

2.2 MATERIALS ANALYZED IN THIS SPD EIS

As discussed in the following graphic, there are eight general categories used to describe the 50 t (55 tons) of surplus plutonium, which represent the physical and chemical nature of the plutonium. Two of the categories—clean metal (including pits) and clean oxide—could either be fabricated into MOX fuel or immobilized. The remaining six categories of material—impure metals, plutonium alloys, impure oxides, uranium/plutonium oxides, alloy reactor fuel, and oxide reactor fuel—would be immobilized.

[2] On June 15, 1999, DOE held a public hearing in Washington, D.C., to solicit comments on the *Supplement to the SPD Draft EIS*.

[3] The potential impacts of fabricating 10 lead assemblies and irradiating 8 of them were analyzed in this SPD EIS. As discussed in Sections 2.18.2 and 4.27, should fewer lead assemblies than analyzed be fabricated or irradiated, the potential impacts would be lower than those described.

DESCRIPTION OF SURPLUS PLUTONIUM BY DISPOSITION FEED CATEGORIES

PLUTONIUM FEED FOR IMMOBILIZATION OR MOX FUEL FABRICATION:

Clean Metal. Pure plutonium metal generally with less than 100 parts per million (ppm) of any given chemical impurity. The metal may have some oxidation or casting residues on the surface. The only major chemical impurities are gallium and radioactive decay products such as americium, neptunium, or uranium. Examples of pure metal items include unalloyed "buttons" of plutonium metal, billets, ingots, castings or rough machined items, finished machined weapon components such as "pits," and other miscellaneous small metal pieces and parts.

Clean Oxide. Plutonium oxides with less than 3 percent by weight of impurities.

FEED FOR IMMOBILIZATION:

Impure Metal. Items with impurities that are more than 100 ppm, but less than 50 percent by weight.

Plutonium Alloys. Plutonium-containing alloys with impurities that are less than 50 percent by weight. Examples of plutonium alloy items include alloyed plutonium "buttons," casting products, machined product items, and ingots.

Impure Oxide. Plutonium oxides with at least 3 but less than 50 percent by weight of impurities. Examples in this category include plutonium oxides containing uranium oxides and plutonium oxides containing neptunium, thorium, beryllium, or zirconium.

Uranium/Plutonium Oxide. Plutonium oxides mixed with enriched uranium oxides. Examples include powders or pellets that have been either low-fired (heated at temperatures below 700 °C) or high-fired (heated at temperatures greater than 700 °C).

Alloy Reactor Fuel and Oxide Reactor Fuel. Plutonium-containing reactor fuel that has been manufactured, but not irradiated in a reactor. The plutonium consists of 12 to 26 percent of plutonium 240 with total plutonium compositions being 13 to 27 percent of the material in the fuel. The fuel can be either alloy reactor fuel or reactor fuel containing plutonium oxide mixed with uranium oxide. The majority of alloy reactor fuel in DOE's plutonium inventory is fuel elements for the Zero Power Physics Reactor at ANL–W. Oxide fuels include experimental capsules, elements, and pins.

Source: DOE, *Feed Materials Planning Basis for Surplus Weapons-Usable Plutonium Disposition*, MD-0009, 1997.

2.3 DEVELOPMENT OF THE ALTERNATIVES

This section describes the development process for those SPD EIS alternatives and technical issues that remained to be finalized after issuance of the *Storage and Disposition PEIS* ROD.

2.3.1 Development of Facility Siting Alternatives

In the ROD for the *Storage and Disposition PEIS,* DOE identified a large number of possible options to locate three disposition facilities at four sites, and limited the immobilization options to Hanford and SRS. In addition to the four different sites for potential facility locations, the options were further increased by considering the use of either existing or new facilities at the sites, and by considering whether disposition would occur by the hybrid approach (both MOX fuel and immobilization) or only through immobilization. The following equally weighted screening criteria were used to reduce the large number of possible facility and site combinations to the range of reasonable alternatives:

- *Worker and public exposure to radiation.* This criterion was used to exclude the site combinations that involve large amounts of handling, packaging, and repackaging of the surplus plutonium for either intersite or intrasite transportation.

- *Proliferation concerns due to transportation of materials.* Application of this criterion eliminated those options that increased the transfers of the surplus plutonium, usually involving three sites.

- *Infrastructure.* This criterion was used to exclude the site combinations where a single disposition facility was located at a site with no benefit for the program or DOE. For example, collocation of two of the three hybrid case disposition facilities at a site would reduce program infrastructure costs such as

those associated with safeguards and security features, whereas locating each facility at a separate site would not allow such functions to be shared.

Over 64 options were evaluated, yielding a range of 20 reasonable alternatives that met all the criteria. Examples of options that were eliminated include all those options placing three facilities at three different sites. In its Notice of Intent (NOI), DOE proposed to collocate the pit conversion and immobilization facilities for the immobilization-only alternatives. However, during the public scoping process, the comment was made that, under all situations, Pantex should be considered as a candidate site for the pit conversion facility because most of the surplus pits are currently stored there. After confirming that they met all the screening criteria, three additional immobilization-only alternatives, which placed the pit conversion facility at Pantex, were included in the range of reasonable alternatives evaluated in the SPD Draft EIS. The number of reasonable alternatives was reduced to 15 in the *Supplement* when DOE determined, as discussed in Section 2.3.2.2 of this SPD EIS, that Building 221–F at SRS was no longer a reasonable location for the immobilization facility.

[Text and table deleted.]

2.3.2 Alternatives Considered but Eliminated From Detailed Study

Technology alternatives for surplus plutonium disposition that were evaluated in the *Storage and Disposition PEIS*, but were not selected in the ROD and, therefore, are not being considered in this SPD EIS are: (1) deep-borehole direct disposition; (2) deep-borehole immobilized disposition; (3) electrometallurgical treatment; (4) MOX fuel irradiation in a partially completed light water reactor; and (5) MOX fuel irradiation in an evolutionary advanced light water reactor. The reasons why these technologies were not selected are explained in the ROD for the *Storage and Disposition PEIS*.

Alternatives considered for inclusion in this SPD EIS but later eliminated from further analysis fall into four categories: amounts of material to be dispositioned, disposition facility siting, feed preparation methods, and immobilization technologies.

2.3.2.1 Amounts of Material to Be Dispositioned

In the *Storage and Disposition PEIS* ROD, DOE committed to immobilizing at least 8 t (9 tons) of surplus, low-purity, nonpit plutonium. Since the ROD was issued, however, DOE has determined that because of the level of impurities and additional processing that would be required to meet MOX fuel specifications, an additional 9 t (10 tons) of low-plutonium-content materials would be immobilized.

2.3.2.2 Disposition Facility Siting Alternatives

In addition to alternatives eliminated by the screening process described earlier, the following facility options were eliminated from further study. Several commentors at the public scoping meetings suggested that DOE consider locating the proposed surplus plutonium disposition facilities at three separate sites. As discussed in Section 2.3.1, DOE is striving to minimize worker and public exposure to radiation, minimize proliferation concerns associated with transportation, and reduce infrastructure cost. These goals would not be met if DOE were to build one facility at each of three candidate sites.

Locating all three proposed facilities in FMEF at Hanford was listed as Alternative 2 in Table 1 of the NOI for preparation of this SPD EIS (DOE 1997b). After further evaluation of space requirements, DOE concluded that the available space in FMEF would not be sufficient to accommodate the efficient operation and maintenance of all three facilities. Therefore, Alternative 2 was modified to collocate only the pit conversion and immobilization facilities in FMEF, with the MOX facility in new construction adjacent to FMEF.

The *Storage and Disposition PEIS* ROD stated that "to accomplish the plutonium disposition mission, DOE will use, to the extent practical, new as well as modified existing buildings and facilities for portions of the disposition mission." The subsequent NOI for the SPD EIS further stated that "construction of these facilities would be on previously disturbed land and could include the modification of existing facilities where practicable, to reduce local environmental impacts, reduce costs, and shorten schedules." As a result, DOE analyzed immobilization alternatives that included Building 221–F at SRS in the SPD Draft EIS. This building was originally built to house operations to chemically separate plutonium from irradiated targets and will be available to support other missions after these activities have been completed. The availability of Building 221–F coincides with the schedule for the proposed surplus plutonium disposition activities.

However, based on revised space requirements for the immobilization facility, the eight alternatives (3B, 5B, 6C, 6D, 7B, 9B, 12B, and 12D) in the SPD Draft EIS that proposed using a portion of Building 221–F for immobilization activities have, as discussed in the *Supplement*, been removed from consideration. These alternatives are no longer considered reasonable because the amount of new construction required for the proposed immobilization facility is now expected to be nearly the same whether the facility were located entirely in a new building or built in addition to using the available portion of Building 221–F. Deletion of the Building 221–F alternatives does not eliminate SRS from any of the immobilization alternatives under consideration. DOE is still evaluating alternatives that involve construction of a new immobilization facility at SRS.

As described in Section 2.7.2 of the SPD Draft EIS, an immobilization facility using portions of Building 221–F was estimated to require approximately 5,300 m^2 (57,000 ft^2) of space in Building 221–F and an additional 1,400 m^2 (15,000 ft^2) of process space in a new annex for a canister-loading facility, for a total of approximately 6,700 m^2 (72,000 ft^2) of space. As discussed in the *Supplement*, and as shown in Section 2.7.1 of this SPD Final EIS, the immobilization facility is now estimated to require approximately 25,000 m^2 (269,000 ft^2) of space. Because only 5,300 m^2 (57,000 ft^2) of this space could be accommodated in Building 221–F, there is no longer expected to be any advantage associated with the use of Building 221–F in terms of reducing the local environmental impacts, reducing costs, or shortening the construction schedule for this facility.

[Text deleted.]

2.3.2.3 Feed Preparation Methods for Immobilization

The homogenous ceramic immobilization facility evaluated in the *Storage and Disposition PEIS* was based on a wet-feed preparation process. Although the ceramic form of the can-in-canister approach evaluated in this SPD EIS could also use a wet-feed process, it would require larger quantities of water and generate greater amounts of waste than would a dry-feed process. For these reasons, wet-feed preparation processes for the ceramic can-in-canister approach were not considered to be reasonable and were not considered further in this SPD EIS.

2.3.2.4 Immobilization Technology Alternatives

DOE considered locating an adjunct melter adjacent to the Defense Waste Processing Facility (DWPF) at SRS. In the adjunct melter, a mixture of borosilicate glass frit and plutonium would be melted together and added directly to borosilicate glass containing high-level waste (HLW) from DWPF. Subsequent evaluations (UC 1997), however, have indicated that the adjunct melter approach would be less technically viable, would take longer to implement, and would cost twice that of the can-in-canister approach. A description of the vitrification process using the adjunct melter is presented in Appendix C, but this approach is not evaluated as a reasonable alternative.

The technology variants for the new immobilization facilities discussed in the *Storage and Disposition PEIS* considered using either radioactive cesium 137 or HLW as a radiation barrier. However, the *Storage and*

Disposition PEIS further identified that, in the can-in-canister approach, the use of HLW to produce a radiation barrier eliminates the need for introducing cesium 137 (from cesium capsules currently in storage at Hanford) into the immobilization process, which in turn reduces radiation shielding requirements and potential exposures to workers and the public. Therefore, this SPD EIS does not include the use of these cesium 137 capsules in the can-in-canister analyses as a reasonable alternative.

2.4 OVERVIEW OF PROPOSED SURPLUS PLUTONIUM DISPOSITION FACILITIES AND TRANSPORTATION

As discussed previously, three facilities are proposed for surplus plutonium disposition: pit conversion, immobilization, and MOX fuel fabrication. The three disposition facilities are proposed for locations where the plutonium would have the levels of protection and control required by applicable DOE safeguards and security directives.[4] Safeguards and security programs would be integrated programs of physical protection, information security, nuclear material control and accountability, and personnel assurance. Security for the facilities would be implemented commensurate with the usability of the material in a nuclear weapon or improvised nuclear device. Each facility would be located at an existing DOE site that has sitewide security measures in place, including access control. In addition to DOE sitewide security services, each facility would have appropriate security features. Physical barriers; access control systems; detection and alarm systems; procedures, including the two-person rule (which requires at least two people to be present when working with special nuclear materials in the facility); and personnel security measures, including security clearance investigations and access authorization levels, would be used to ensure that special nuclear materials stored and processed inside are adequately protected. Nuclear material control and accountability would be ensured through a system that monitors storage, processing, and transfers. Closed-circuit television, intrusion detection, motion detection, and other automated material monitoring methods would be employed as part of the material control and accountability program. At any time, the total amount of special nuclear material in each facility, or in any material balance area within a specific facility, would be known. Physical inventories, measurements and inspections of material both in process and in storage would be used to verify inventory records. In addition, each of the three facilities would need to provide space and, to varying degrees, access for international inspection.

Descriptions of the proposed surplus plutonium disposition facilities and process operations are provided in this section. The proposed facility layouts are renderings that show representative equipment layouts that demonstrate functional, but not final designs. These designs are subject to modification during the design and construction process, consistent with any construction project, as may be required to optimize equipment placement and process flow. Sections 2.5 through 2.16 describe, individually, each alternative being considered in this SPD EIS. Because the facilities would be implemented differently at each site and for each alternative, those differences are identified and described. Sections 2.4 through 2.16 were developed using data provided by the Regents of the University of California (UC 1998a–i, 1999a–d). MOX alternatives have also been developed using data provided in the *MOX Fuel Fabrication Facility and Nuclear Power Reactor Data Report* (DOE 1999a) and by ORNL (ORNL 1998, 1999).

Each of the three disposition facility layouts includes accommodations for international inspection. However, the implementation process for international inspection of U.S. and Russian surplus plutonium is not fully defined. Rather, that process is part of ongoing negotiations being conducted to reach a bilateral plutonium disposition agreement between the United States and Russia for their disposition programs in accordance with the *Joint Statement of Principles for Management and Disposition of Plutonium Designated as No Longer Required for Defense Purposes*. This statement was signed by Presidents Clinton and Yeltsin in September 1998

[4] The physical protection and safeguards and security for the MOX facility would be acceptable to NRC. Physical protection and safeguards and security at the domestic, commercial reactors would meet NRC regulations.

(see Appendix A). The agreement could include provisions for bilateral facility inspections or potential multilateral inspections.

Each of the disposition facilities is proposed to operate for about 10 years. However, the operating life of the facilities may vary somewhat, depending on facility startup experiences and international negotiations regarding the pace of disposition. Also, the MOX facility could operate for as long as 13 years to accommodate the fuel cycles of the reactors in which the MOX fuel would be used. Slightly more or less material could be processed in any given year, potentially extending or shortening the operating period of any of the disposition facilities. Also, for the hybrid approach, it may be necessary, based on feed material quality, to process slightly more material by immobilization than currently envisioned. An analysis of how these adjustments could incrementally affect the potential impacts evaluated in this SPD EIS is provided in Section 4.30.

Because the disposition facilities would operate for about 10 years and would meet stringent safety and natural hazard requirements, they could still be used for other programs or activities. As discussed in Section 4.31, after completion of the surplus plutonium disposition mission, equipment would be removed, decontaminated, and either reused at other DOE facilities or disposed of, and the facilities would be stabilized to a condition suitable for reuse. It is expected that this facility deactivation would take 3 years or less to complete. During this time, DOE would perform engineering evaluations, environmental studies, and further NEPA review to assess the consequences of different courses of action with respect to these facilities.

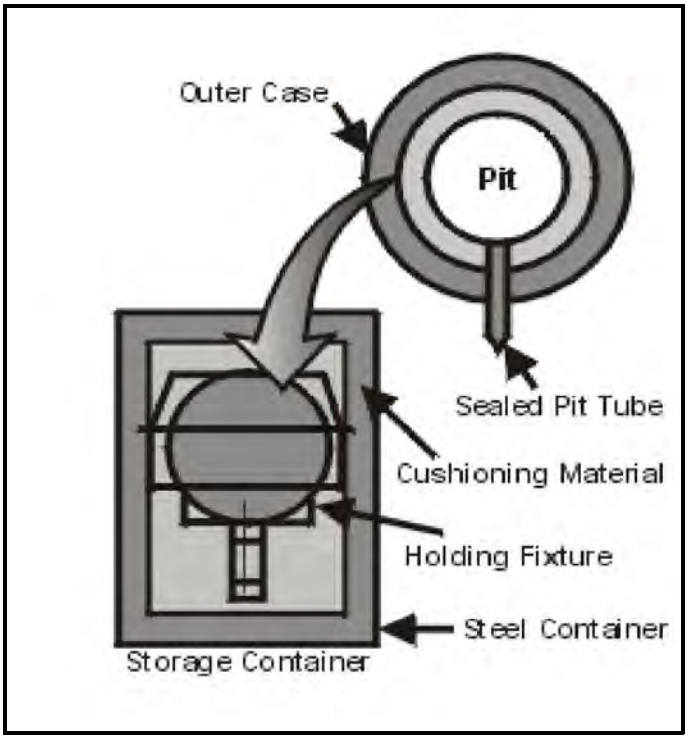


Figure 2–6. Depiction of a Pit

2.4.1 Pit Disassembly and Conversion

Each surplus plutonium disposition action alternative requires a pit conversion facility to produce appropriate plutonium dioxide feed material. That facility would recover plutonium from pits (see Figure 2–6) and process clean plutonium metal (as described in Section 2.2); convert the plutonium to an unclassified (i.e., no longer exhibiting any characteristics that are protected for reasons of national security) oxide; and then transfer the oxide to either the immobilization facility or the MOX facility. This process would include the removal of gallium, beryllium, or other materials that may be considered impurities in plutonium dioxide feed for MOX fuel fabrication. Potential impurities include any of the elements listed in Table 2–2. Given the national security sensitivity of information on pit materials and assembly, pit conversion facility operations

Table 2–2. Potential Impurities in Weapons-Grade Plutonium

Aluminum	Magnesium
Americium	Manganese
Boron	Nickel
Beryllium	Neptunium
Carbon	Silicon
Calcium	Tantalum
Cadmium	Tin
Chromium	Thorium
Copper	Titanium
Gallium	Tungsten
Iron	Uranium
Lead	Zinc

would be classified (i.e., access restricted) through the material-processing steps, and possibly through the final canning stage.

2.4.1.1 Pit Conversion Facility Description

The pit conversion facility would be designed to process up to 3.5 t (3.8 tons) of plutonium metal into plutonium dioxide annually. Facility operations would require a staff of about 400 personnel. The general layout of the pit conversion facility, which approximates how the pit conversion process would be implemented, is presented in Figures 2–7 and 2–8. The specific layout and design of the facility would vary from site to site depending on a number of factors, as discussed in Sections 2.6 through 2.16.

The pit conversion facility would be built in a hardened space of thick-walled concrete that meets all applicable standards for processing special nuclear material. One or possibly both levels of the two-story building would be below grade. Areas of the facility in which plutonium would be processed or stored would be designed to survive natural phenomena such as earthquakes, floods, and tornadoes, as well as potential accidents associated with fissile and radioactive materials. Ancillary buildings would be required for support activities.

Activities involving radioactive materials or externally contaminated containers of radioactive materials would be conducted in gloveboxes. The gloveboxes would be interconnected by a contained conveyor system to move materials from one process step to the next. Gloveboxes would remain completely sealed and operate independently, except during material transfer operations. Built-in safety features would limit the temperature and pressure inside the gloveboxes and ensure that operations remained within criticality safety limits. When dictated by process needs or safety concerns, an inert atmosphere would be maintained in gloveboxes. The exhaust from the gloveboxes would be monitored continuously for radioactive contamination. The atmosphere in the gloveboxes would be kept at a lower pressure than that of the surrounding areas so that any leaks of gaseous or suspended particulate matter would be contained and filtered appropriately. The building ventilation system would include high-efficiency particulate air (HEPA) filters and would be designed to maintain confinement, thus precluding the spread of airborne radioactive particulates or hazardous chemicals within the facility or to the outside environment. Both intake and exhaust air would be filtered, and exhaust gases would be monitored for radioactivity.

Beryllium may be a constituent of some of the pits that would be disassembled in the pit conversion facility. Because inhalation of beryllium dust and particles has been proven to cause a chronic and sometimes fatal lung disease, beryllium is of special interest from a health effects perspective. The process operations in the pit

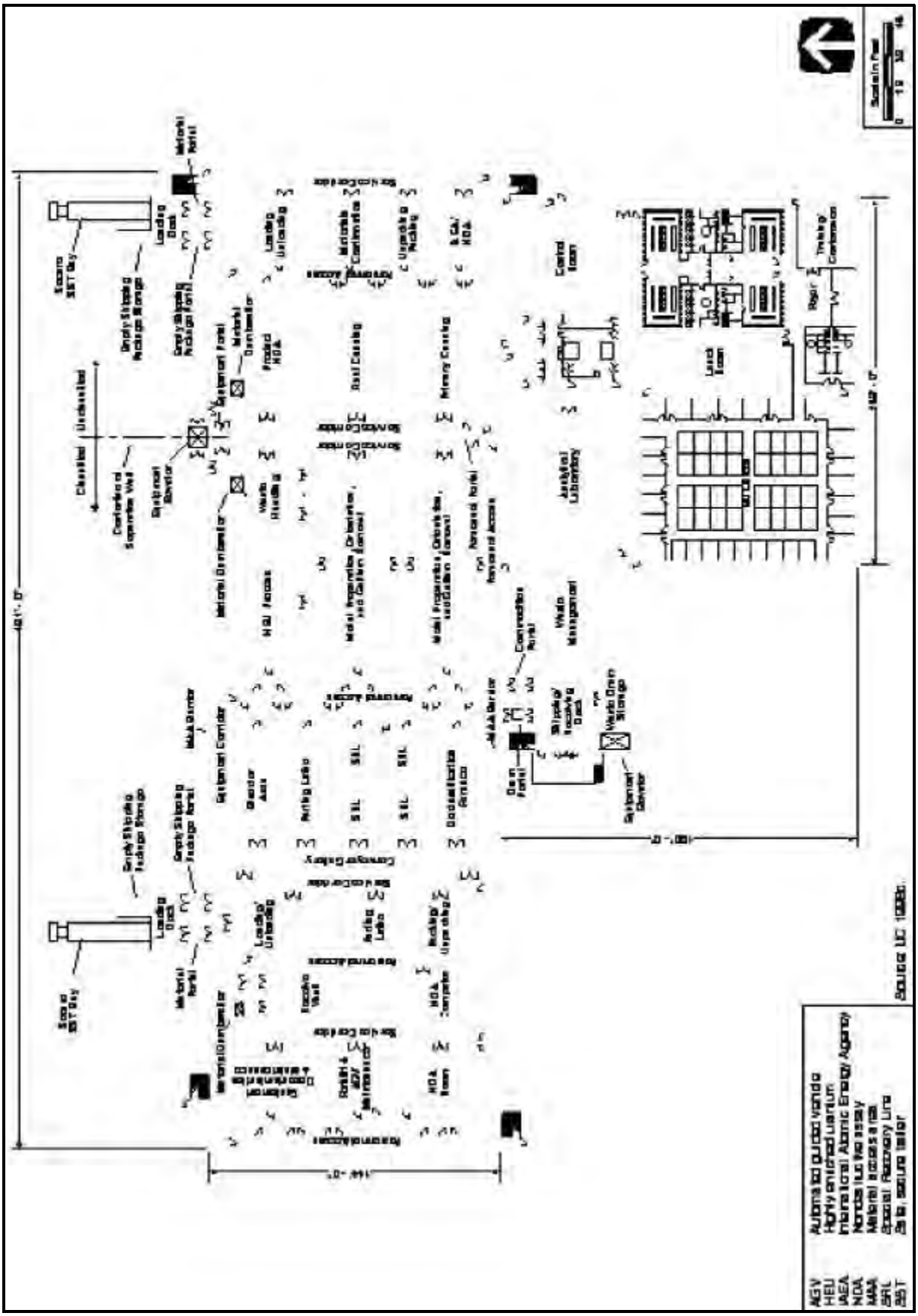


Figure 2–7. General Design of Pit Conversion Facility—Main Processing Level (First Floor)

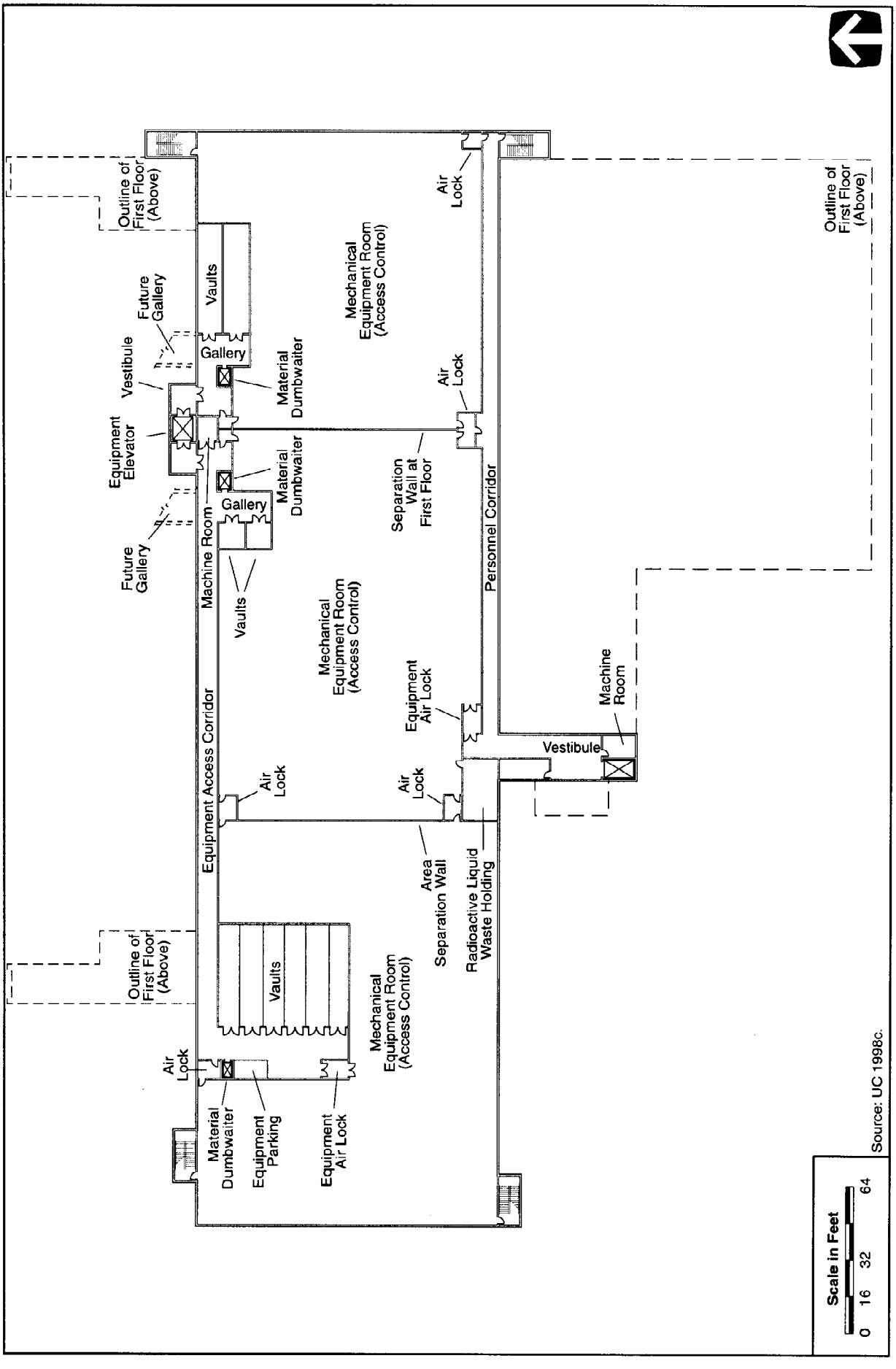


Figure 2–8. General Design of Pit Conversion Facility—Lower (Basement) Level

conversion facility are expected to generate only larger, nonrespirable turnings and pieces of metal, and all work would be performed in gloveboxes. No grinding would be done that could cause small pieces of beryllium to become airborne. The beryllium in solid form would be disposed of as low-level waste (LLW) or transuranic (TRU) waste and has been included in the waste estimates presented in Chapter 4. Therefore, exposure to airborne beryllium is not considered a concern for pit disassembly and conversion operations.

The pit conversion facility would accommodate the following surplus plutonium-processing activities: pit receipt, storage, and preparation; pit disassembly; plutonium conversion; gallium removal; oxide blending and sampling; nondestructive assay; product canning; product storage; product inspection and sampling for international inspection; product shipping; declassification of parts not made from special nuclear materials; highly enriched uranium (HEU) decontamination, packaging, storage, and shipping; tritium capture, packaging, and storage; and waste packaging, sampling, and certification. Additional areas for support activities would be needed, including office space, change rooms, a central control room, a laboratory, mechanical equipment rooms, mechanical shops, an emergency generator to supply power to critical safety systems in the event of a power outage, a warehouse, shipping and receiving areas, waste storage, guard stations, entry portals, and parking. Because these facilities would not contain or process special nuclear materials, they would not be required to be in hardened space and thus could be located in other space available at the candidate sites. Separate truck bays in the hardened facility would accommodate DOE safe, secure trailer/SafeGuards Transport (SST/SGTs).

2.4.1.2 Pit Disassembly and Conversion Process

The pit disassembly and conversion process is depicted in Figure 2–9. At the pit conversion facility, the storage containers would be removed from their overpacks (outer shipping containers), the contents verified, and information regarding the material entered into the facility's material accountability system. Pits and plutonium metal would be placed in a short-term receiving vault, checked for radiological contamination, and transferred to the pit storage vault until processing. Before pits would be fed into the pit disassembly line, they would be segregated based on the potential presence of tritium.[5] Pits without tritium would go into the pit bisector glovebox, and those containing tritium would start in the Special Recovery Line glovebox.

In the pit bisector glovebox, any external structures would be cut away from the pit, and the pit would be cut in half. Nonbonded pits (pits whose components separate easily) would be separated into plutonium metal, HEU, classified metal shapes, and classified nuclear material parts. The plutonium parts would be assayed as part of the material accountability program. HEU would be sent to the HEU-processing station for material accountability, electrolytic decontamination, and packaging; the classified metal shapes and metal shavings to the declassification furnaces; the nuclear material parts to storage at the pit conversion facility; and the plutonium to the hydride-oxidation (HYDOX) station for the next step of the process. Bonded pits, which cannot be separated prior to processing, would be sent to the HYDOX station intact. For these pits, HEU, classified metal shapes, and classified nuclear material parts would be separated from the plutonium metal during the HYDOX process, then sent to the HEU-processing station, declassification furnaces, and storage at the pit conversion facility, respectively. Recovered HEU would be stored in a vault at the pit conversion facility until shipped to the Oak Ridge Reservation (ORR) for declassification, storage, and eventual disposition. The HEU would meet the Y–12 acceptance criteria prior to shipment to ORR.

Pits with tritium would also be bisected, and the HEU, classified metal shapes, and classified nuclear material parts would be separated from the plutonium; this would occur in the Special Recovery Line glovebox. Under normal circumstances, all the tritium associated with a given pit would be captured and recovered during the

[5] Tritium can be used as a boosting fuel in high-energy atomic weapons. Although the operators of the pit conversion facility would know which pits contain tritium, the pit types and the number of surplus pits that contain tritium are classified.

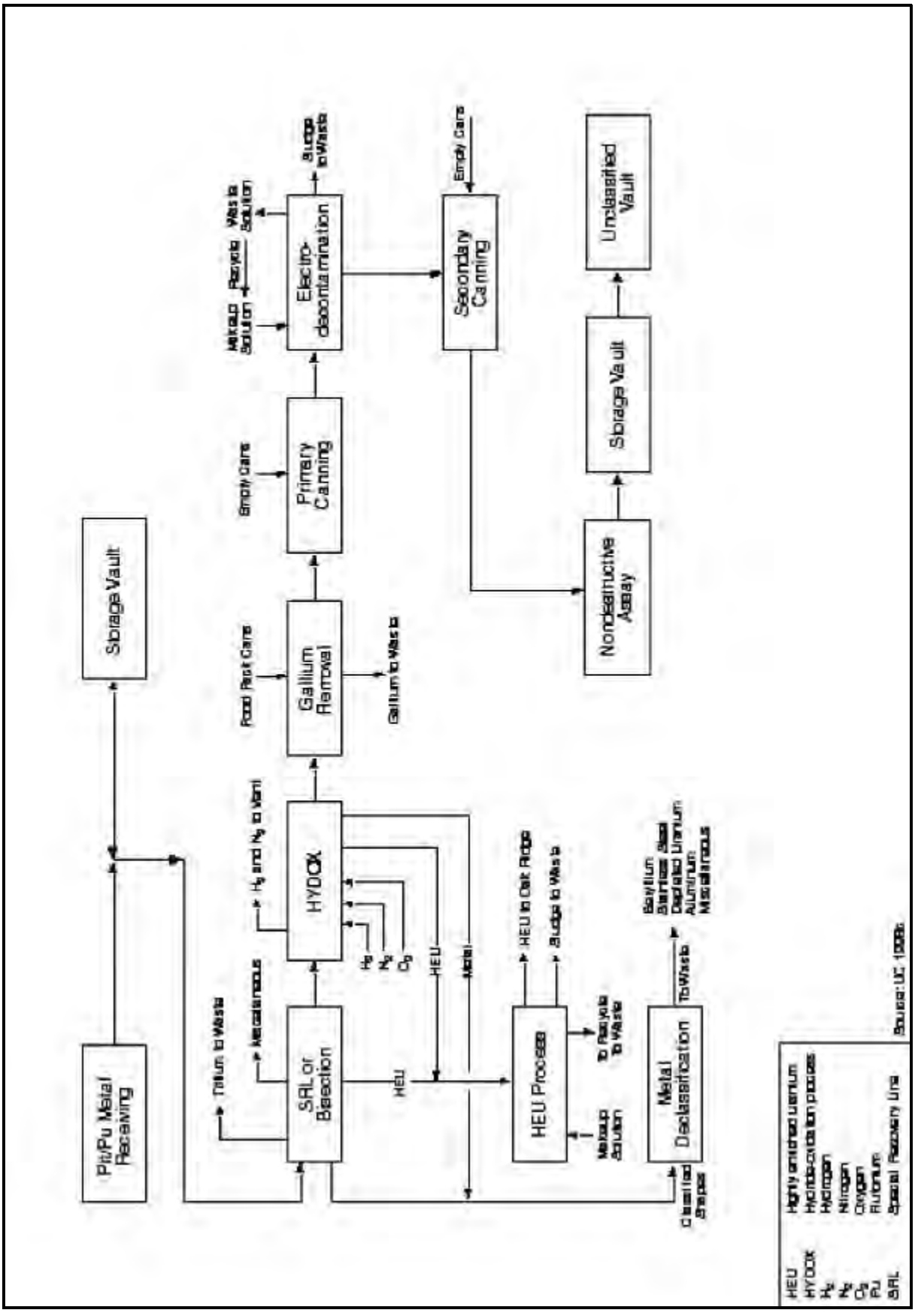


Figure 2–9. Pit Disassembly and Conversion Process

tritium removal process in the Special Recovery Line. It is expected that in a small number of pits, the tritium will have absorbed into the plutonium. For these pits, an additional step would occur in the Special Recovery Line glovebox: the plutonium would be heated in a vacuum furnace to drive off the tritium as a gas. The tritium would then be captured on a catalyst bed and packaged as LLW for treatment and disposal. For purposes of analysis in this SPD EIS, it has been conservatively estimated that 1,100 Ci of tritium would escape to the atmosphere annually through the process building stack. HEU and classified metal shapes would be decontaminated and sent to the HEU-processing station and declassification furnaces, respectively; classified nuclear material parts would be placed in storage at the pit conversion facility. After confirmation that the plutonium metal was free of tritium, the plutonium would be assayed as part of the special nuclear material accountability program and transferred to the HYDOX station. Recovered HEU would be stored in a vault at the pit conversion facility until shipped to the ORR for declassification, storage, and eventual disposition. The HEU would meet the Y–12 acceptance criteria prior to shipment to ORR.

In the HYDOX module, plutonium metal would react with hydrogen, nitrogen, and oxygen at controlled temperatures and pressures in a pressure vessel to produce plutonium dioxide. The plutonium metal would first be reacted with hydrogen gas to form a hydride. Then the vessel would be purged of the hydrogen and the hydride reacted with nitrogen gas to form a nitride. The nitrogen would then be purged and replaced with oxygen for the final reaction forming plutonium dioxide. The plutonium dioxide product would be collected and assayed for the material accountability program to confirm that all the plutonium metal entering the HYDOX process left as an oxide.

Next in this process would be gallium removal. Gallium, a metallic element with a low melting point that is alloyed with plutonium in pits, is considered an impurity in plutonium dioxide feed for MOX fuel fabrication.[6] As currently proposed and analyzed in this SPD EIS, the pit conversion process includes a gallium removal step in which heat would be used in a controlled manner to separate and collect (for disposal as LLW or TRU waste) gallium oxide from plutonium dioxide. Following gallium removal, the plutonium dioxide would be subjected to a series of tests to verify that it met specifications, sealed in a metal can, and sent to the primary canning module.

This gallium removal process was evaluated in the SPD Draft EIS as meeting the needs of the surplus plutonium disposition program. However, as explained in the *Supplement*, based on public comments, and the responses to the procurement discussed in Section 2.1.3 of this SPD Final EIS, the plutonium-polishing process for gallium removal that was evaluated as a contingency in Appendix N of the SPD Draft EIS has been included in the MOX facility evaluated in this SPD Final EIS. Plutonium polishing consists of a small-scale aqueous process to remove gallium (and the other impurities that can affect the use of the plutonium as reactor fuel) to a greater extent than the dry, thermal process proposed for the pit conversion facility. Because the MOX facility would include the plutonium-polishing component, it may not be necessary to subject the plutonium dioxide to the thermal gallium removal step at the pit conversion facility. Both the pit conversion and MOX facilities, however, are being analyzed with their respective gallium (and other impurity) removal processes. Should it be determined that the thermal process is not needed, the impacts of operating the pit conversion facility, in particular, electrical use and waste generation, would be lower than those estimated in this SPD Final EIS.

In the primary canning module, the cans of plutonium dioxide would be placed into a primary storage can made of stainless steel. This can would then be welded shut and leak tested to ensure that the weld was sound. If the can were to fail the leak test, it would be reopened and rewelded. After passing the leak test, the primary can would be sent to the electrolytic decontamination module. After decontamination, each can would be rinsed, dried, and surveyed to verify decontamination, then sent to the secondary canning module.

[6] Gallium removal would not be necessary for material that would be immobilized.

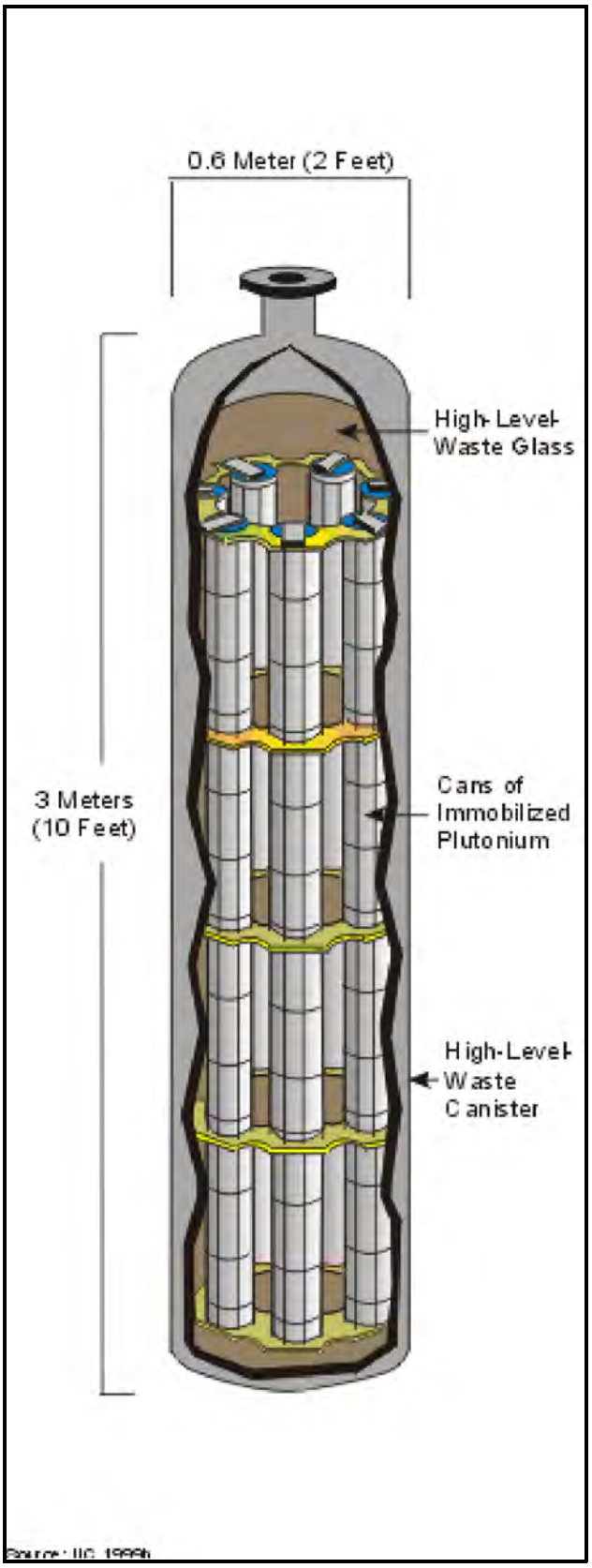


Figure 2–12. Cutaway View of Can-in-Canister Approach

and standby generators would provide backup power for critical systems. This arrangement would ensure that critical systems remain operational during any interruption of offsite power.

2.4.2.2 Plutonium Conversion and Immobilization Process

The plutonium conversion and immobilization process would have the capability to immobilize surplus plutonium material from both pit and nonpit sources. Surplus plutonium derived from pits and already processed by the pit conversion facility would be directly suitable for immobilization, whereas most surplus nonpit plutonium would first have to be converted to a suitable oxide. These oxides would then be incorporated into either a titanate-based ceramic material or a lanthanide borosilicate glass.

The plutonium immobilized in ceramic or glass would be placed inside stainless steel cans, which would be welded shut. The cans would be loaded into an HLW canister (similar to the type currently in use at DWPF at SRS), and filled with HLW to provide a radiation barrier that contributes to the proliferation resistance of the final product. The filled canister, as depicted in Figure 2–12, would then be sealed and stored on the site pending final disposition in a potential geologic repository pursuant to the NWPA. Figure 2–13 provides an overview of the ceramic and glass can-in-canister immobilization processes.

2.4.2.2.1 Plutonium Conversion Process

Plutonium feed materials would be transported in DOE SST/SGTs from the pit conversion facility (if not collocated with the immobilization facility) and the DOE sites storing surplus nonpit plutonium. The shipping containers would be unpacked and the nuclear material assayed at the immobilization facility. Several forms of surplus plutonium materials, all unclassified, would be received by the facility: unirradiated metal reactor fuel in the form of pins and plates clad in stainless steel (from the Zero Power Physics Reactor [ZPPR] at INEEL), unirradiated oxide reactor fuel consisting of fuel pins and bundles (from the Fast Flux Test Facility [FFTF] at Hanford), plutonium alloys, metals, and

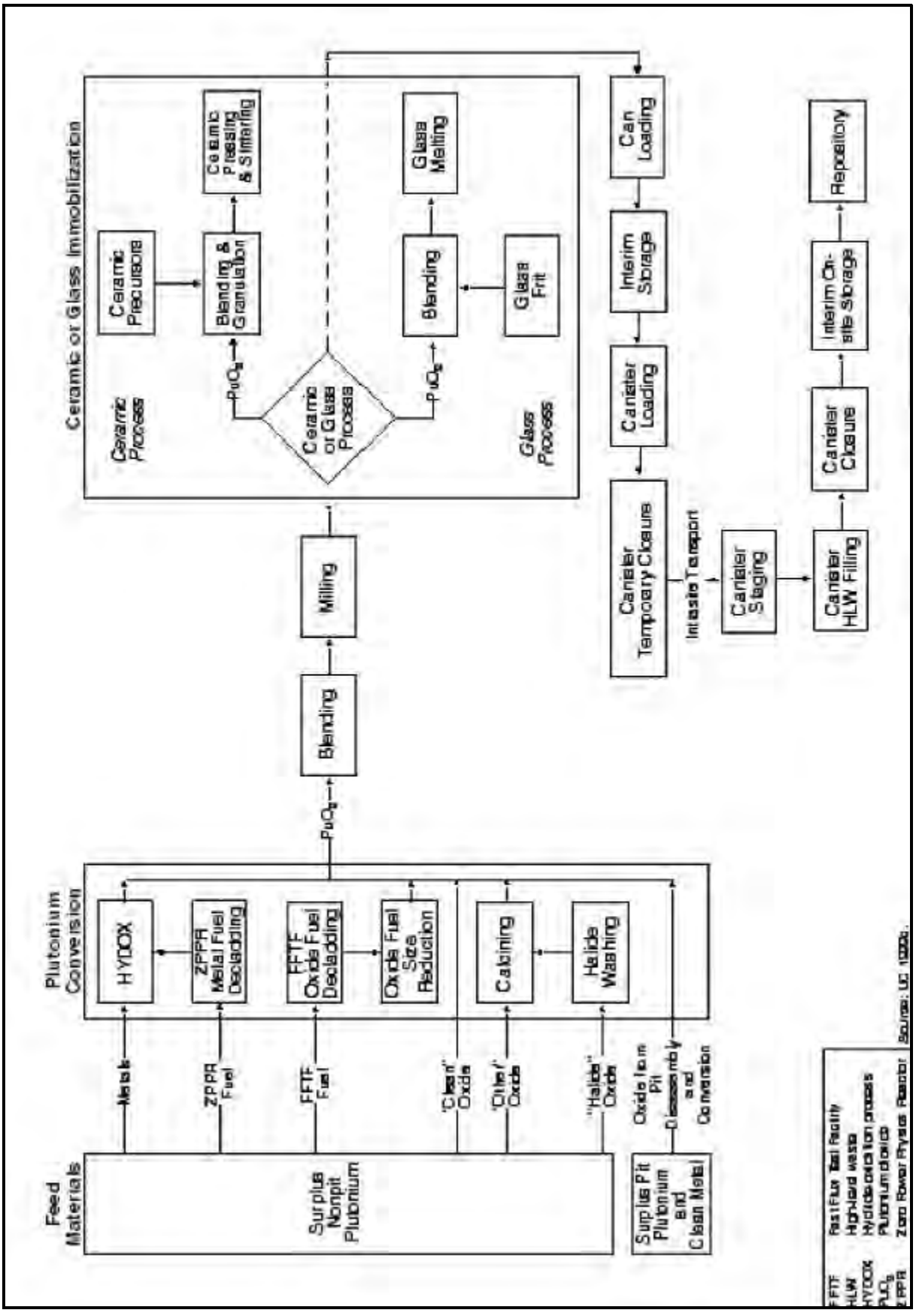


Figure 2–13. Can-in-Canister Process

oxides. Some of these feed materials would also have a uranium component. A feed material storage vault would be available to store up to 6 months of incoming plutonium feed materials. Individual containers would be transferred from the feed material storage vault to a glovebox, unpacked, and inspected to determine the conversion process necessary to render the feed material suitable for immobilization. Metals and alloys would be converted to oxide using the HYDOX process. Metal reactor fuel may require decladding before HYDOX conversion. Oxide reactor fuel would also be decladded, and the individual fuel pellets removed and sorted according to fissile material content. Pellets containing plutonium or enriched uranium would then be ground to an acceptable particle size. Oxides containing moisture or impurities would undergo a calcining process; oxides containing significant concentrations of halide impurities would be "washed" with water to remove the halides before calcining could take place.

Following these conversion processes, the plutonium materials would be stored in the in-process storage vault. Clean oxides—in particular, oxides received from the pit conversion facility, if the decision were made to immobilize all the surplus plutonium—would not require conversion and would be transferred directly to the vault.

2.4.2.2.2 Immobilization Process

Ceramic Process. The ceramic immobilization process would be conducted in a series of glovebox operations that would incorporate the plutonium oxide into ceramic disks, stack the disks inside stainless steel cans, and load the cans into an HLW canister.

In the feed-blending step, plutonium dioxide feed materials would be selected from in-process storage for blending with depleted uranium dioxide. Uranium dioxide would be added to generate a consistent product and reduce criticality concerns, and neutron absorbers (for example, the elements gadolinium or hafnium) would be added to provide criticality safety in the ceramic product. As explained in Section 1.5, uranium dioxide made from depleted uranium hexafluoride in storage at the gaseous diffusion plants previously operated by DOE, such as the Portsmouth Gaseous Diffusion Plant, would be used for this purpose.

After blending, each batch of feed material would be milled to reduce the size of the oxide powder, then blended with ceramic precursors. This mixture would then be granulated with an organic binder to produce a pourable feed that would hold together adequately when compacted into disks. In the press and sinter step, the mixture would be fed into a hydraulic press to form disks, which in turn would be baked in a furnace for reactive sintering to produce the desired mineral phases in the ceramic form. The final product would consist of homogeneous disks about 6.3 cm (2.5 in) in diameter by 2.5 cm (1 in) in height, containing about 10 weight-percent plutonium and 20 weight-percent uranium. These disks would then be stacked and sealed inside stainless steel cans. The cans would be leak tested, assayed, loaded into magazines, and stored in the product vault until removed for canister-filling operations.

As needed, magazines of canned ceramic disks would be removed from storage and inserted and locked into a framework inside an HLW canister. A temporary closure plug would be installed, and following leak testing, the canister would be loaded into a shielded transportation box for intrasite shipment from the main process building to the HLW vitrification facility in a specialized canister transport vehicle.

Glass Process. The glass immobilization process would be conducted in a series of glovebox operations that would incorporate the plutonium oxide into molten lanthanide borosilicate glass, pour it into stainless steel cans, and load the cans into an HLW canister.

In the feed-blending step, plutonium oxide feed materials would be selected from in-process storage for blending to produce individual batches with the desired isotopic composition. Each batch would be milled to reduce the

size of the oxide powder to achieve faster dissolution during the melting process. The milled oxide would then be blended with glass frit (small glass pebbles) containing neutron absorbers (e.g., gadolinium and hafnium) to form a mixture of about 8 weight-percent plutonium and 3 to 8 weight-percent uranium.

This mixture would be fed at a controlled rate into electrically heated melters operating at about 1,500 °C (2,732 °F) to melt the frit and dissolve the plutonium oxide. The homogenous glass melt would be drained into stainless steel cans, which in turn would be sealed, leak tested, assayed, loaded into magazines, and stored in the product vault. As needed, these magazines would be removed from storage and inserted and locked into a framework inside an HLW canister. A temporary closure plug would be installed, and following leak testing, the canister would be loaded into a shielded transportation box for intrasite shipment from the main process building to the HLW vitrification facility in a specialized canister transport vehicle.

Canister Filling. Canister filling, the last major step of the immobilization process, would occur at the HLW vitrification facility. The canisters received from the main process building would be moved individually through an inspection area to the HLW melt cell. In the melt cell, molten, vitrified HLW would be poured into the canister around the stainless steel cans of immobilized plutonium. After removal of any contamination from its outside surface, the canister would be plugged and welded closed. Following inspection and verification that the exterior of the canister was free of contamination, the canister would be transported to an onsite storage vault for interim storage pending final disposition at a potential geologic repository pursuant to the NWPA.

The HLW canisters would measure 0.6 m (2 ft) in diameter by 3 m (10 ft) in height, and, when filled, would weigh up to 2,500 kg (5,500 lb).[10] As each canister of plutonium immobilized in ceramic would contain about 28 kg (61 lb) of plutonium,[11] about 1,820 of these canisters would be required to process all 50 t (55 tons) of surplus plutonium. In the ceramic process, the cans, magazines, and internal framework within each canister would displace approximately 15 percent (by volume) of HLW glass. This would result in 272 canisters more than otherwise planned for the DOE HLW vitrification program. Each canister of plutonium immobilized in glass would contain about 26 kg (58 lb) of plutonium.[11] As such, about 1,900 canisters would be required to vitrify the 50 t (55 tons) of surplus plutonium. Because the cans, magazines, and internal framework used in the glass process would displace approximately 21 percent (by volume) of HLW glass, this would result in 395 canisters more than otherwise planned for the DOE HLW vitrification program. For the hybrid alternatives, about 670 canisters of plutonium immobilized as a ceramic or 690 canisters of vitrified plutonium would be produced. This would result in 101 or 145 additional canisters, depending on whether the immobilized form were ceramic or glass, respectively, than otherwise planned for the DOE HLW vitrification program.

2.4.3 MOX Fuel Fabrication

The MOX facility would produce completed MOX fuel assemblies for use in domestic, commercial reactors. Feed materials would be the plutonium dioxide from the pit conversion facility and uranium dioxide made from either the DOE stockpile of depleted uranium hexafluoride at a representative DOE site (i.e., the Portsmouth Gaseous Diffusion Plant) or another source selected by the fuel fabricator (DCS) and approved by DOE. MOX fuel fabrication involves blending the plutonium dioxide with uranium dioxide; forming the mixed oxide into pellets; loading the pellets into fuel rods; and assembling the fuel rods into fuel assemblies. Once assembled, each of the fuel assemblies would be transported in SST/SGTs to one of the domestic, commercial reactors for

[10] Consistent with the *Storage and Disposition PEIS* and the WM PEIS, the DWPF HLW canister has been used as the reference canister design for the surplus plutonium immobilization program. Although DOE is considering the possibility of using a larger canister for the Hanford HLW vitrification program, the analyses in this SPD EIS also assume that a DWPF-type canister would be used at Hanford.

[11] Plutonium loading in the final design specification and between individual canisters may vary slightly.

use as fuel. Following irradiation, the MOX fuel would be removed from the reactor and managed at the reactor site as spent fuel. Final disposition would be at a potential geologic repository pursuant to the NWPA.

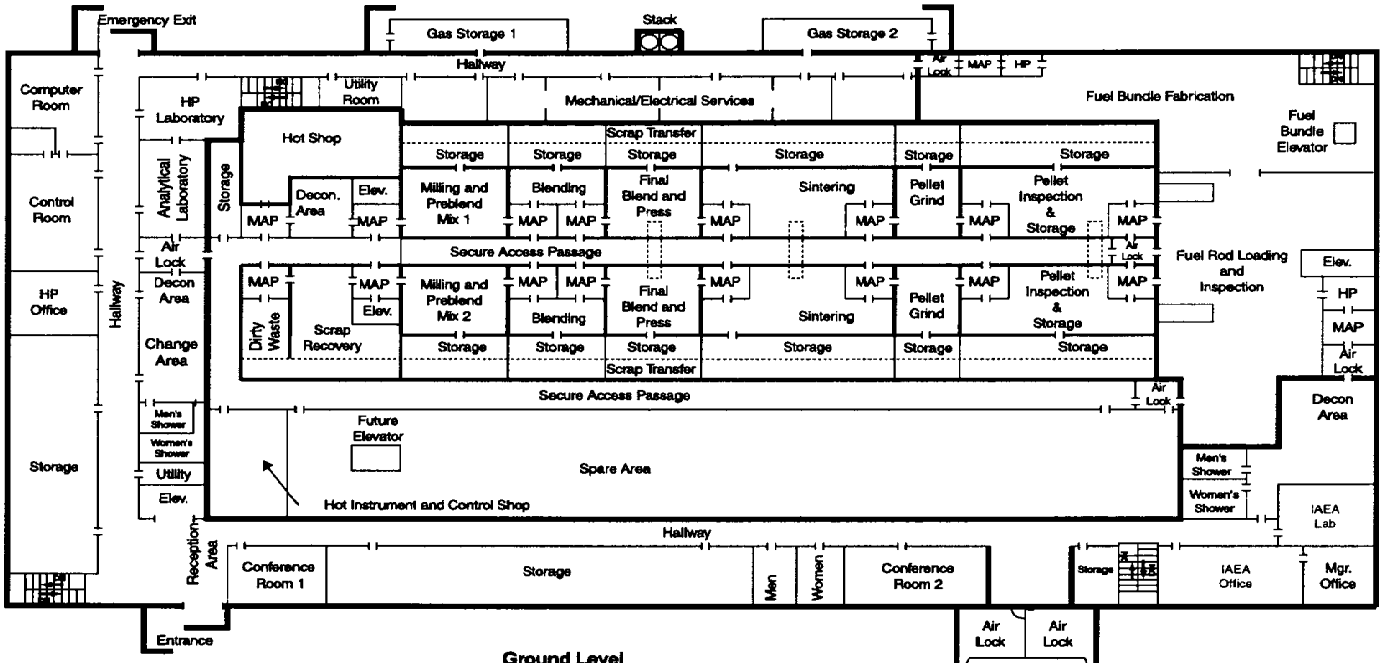
The proposed MOX facility would also include plutonium polishing (a small-scale aqueous process) to remove impurities,[12] in particular gallium, from the plutonium dioxide feed prior to MOX fuel fabrication. This initial plutonium-polishing process would be essentially that described in Appendix N of the SPD Draft EIS, and would add approximately 2,500 m^2 (27,000 ft^2) of process space and about 315 m^2 (3,400 ft^2) of nonhardened space for support functions to the MOX facility. However, the MOX facility layout depicted in Figures 2–14 and 2–15 has not been revised to show this process. This layout approximates how the MOX fuel fabrication process would be implemented. It is a conceptual design that would be updated in subsequent design phases should DOE choose the hybrid approach for surplus plutonium disposition in the ROD. If so, during the design process, the plutonium-polishing component would be integrated into the MOX facility design. The potential impacts of the MOX facility, including plutonium polishing, are evaluated in Chapter 4 and would be the same regardless of where the plutonium-polishing equipment would be located within the MOX facility.

2.4.3.1 MOX Facility Description

The MOX facility would be designed to process up to 3.5 t (3.8 tons) of surplus plutonium (as plutonium dioxide from the pit conversion facility) annually. Facility operations would require a staff of about 385 personnel. The MOX facility has been increased in size from about 11,000 m^2 (120,000 ft^2) in the SPD Draft EIS to about 20,000 m^2 (215,000 ft^2) to include the plutonium-polishing component and additional space proposed by DCS (DOE 1999a). However, about 2,000 m^2 (21,000 ft^2) of administrative space have been relocated from support facilities to the MOX facility, so the net increase in space needed to implement the MOX option is about 7,000 m^2 (75,000 ft^2). As depicted in Figures 2–14 and 2–15, the MOX facility would be a two-story, hardened, reinforced-concrete structure with a below-grade basement and an at-grade first floor. The facility would meet all applicable standards for processing special nuclear material. The walls, floors, and roof of the building would be constructed of about 46 cm (18 in) thick reinforced concrete. Areas of the facility in which plutonium would be processed or stored would be designed to survive natural phenomena such as earthquakes, floods, and tornadoes, as well as potential accidents associated with processing fissile and radioactive materials. Ancillary buildings would be required for support activities.

The fuel fabrication areas, two parallel process lines, would be at ground level. To accommodate the potential for fabricating a different type of fuel, the MOX facility would have sufficient unused space for the installation of another production-scale MOX fuel line. An inert atmosphere would be maintained in gloveboxes where dictated by process needs or safety concerns. The exhaust from the gloveboxes would be monitored continuously for radioactive contamination. The atmosphere in the gloveboxes would be kept at a lower pressure than that of the surrounding areas so that any leaks of gaseous or suspended particulate matter would be contained and filtered appropriately. The building ventilation system would include HEPA filters, and would be designed to maintain confinement, thus precluding the spread of airborne radioactive particulates or hazardous chemicals within the facility and to the outside environment. Both intake and exhaust air would be filtered, and exhaust gases would be monitored for radioactivity. Power would be supplied to the MOX facility by two independent offsite power supplies. An uninterruptible power supply and standby generators

[12] Table 2–2 lists the potential impurities.

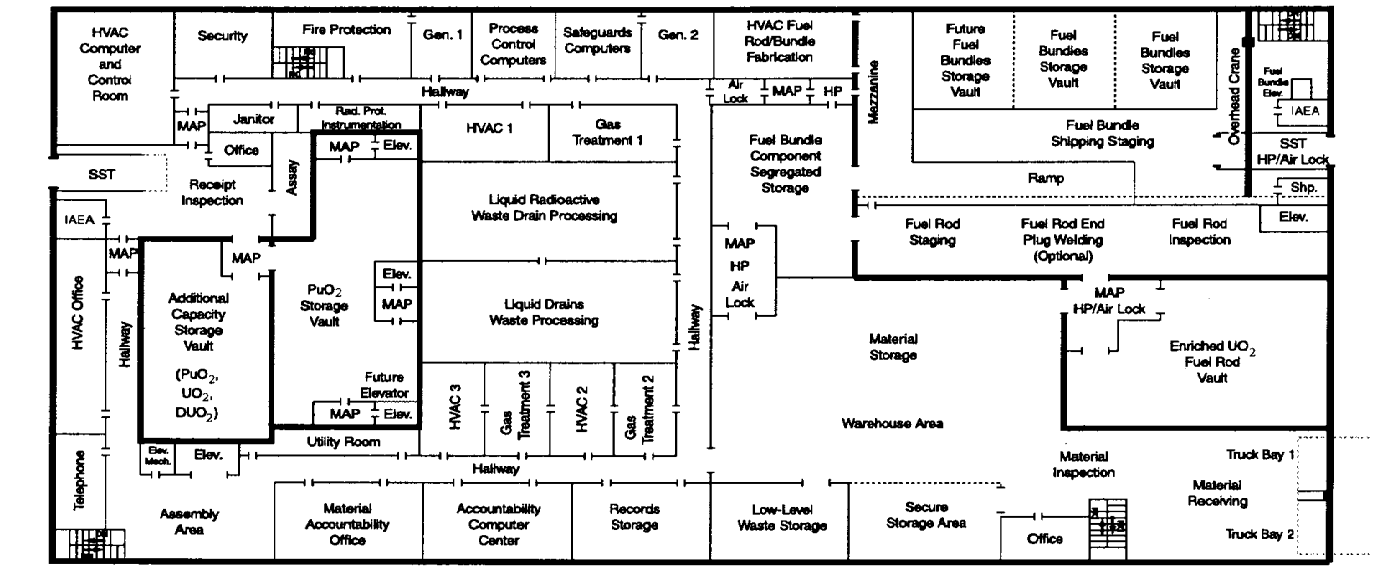


Notes:
1. Not Shown, 10,000–20,000 square foot office facility for related MOX mission support (e.g., training, scheduling, engineering, personnel), 20,000 square foot warehouse area for storage of shipping containers, and layout of plutonium polishing process.
2. Category 1 building.
3. Additional security facilities may be required.
4. Room/area sizes are approximate; actual arrangement will vary.

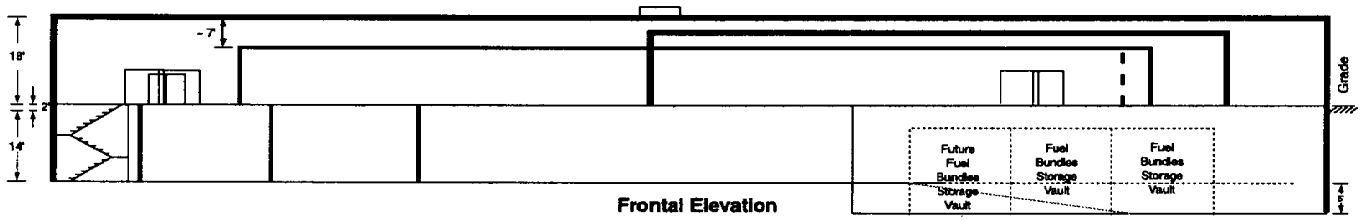
Decon	Decontamination
Elev	Elevator
HP	Health physics
HVAC	Heating, ventilation, and air conditioning
IAEA	International Atomic Energy Agency
Lab	Laboratory
MAP	Materials Accountability Program and safeguards and security functions (actual arrangement may vary)
Mgr	Manager's
▬	Structurally hardened wall
—	Shield wall

Source: UC 1998g.

Figure 2–14. General Design of MOX Facility—Ground Level



Basement Level



Frontal Elevation

DUO_2	Depleted uranium dioxide	Mech	Mechanical
Elec	Electrical	Prot	Protection
Elev	Elevator	PuO_2	Plutonium dioxide
Gen	Generator	Rad	Radiation
HP	Health physics	Shp	Shipping
HVAC	Heating, ventilation, and air conditioning	SST	Safe, secure trailer
IAEA	International Atomic Energy Agency	UO_2	Uranium dioxide
MAP	Materials Accountability Program and safeguards and security functions (actual arrangement may vary)	▬	Structurally hardened wall
		—	Shield wall

Source: UC 1998g.

Notes:
1. Not Shown, 10,000–20,000 square foot office facility for related MOX mission support (e.g., training, scheduling, engineering, personnel), 20,000 square foot warehouse area for storage of shipping containers, and layout of plutonium polishing process.
2. Category 1 building.
3. Additional security facilities may be required.
4. Room/area sizes are approximate; actual arrangement will vary.

Figure 2–15. General Design of MOX Facility—Basement Level and Frontal Elevation

would provide backup power for critical systems. This arrangement would ensure continued operation of critical systems during any interruption of offsite power.

The basement level of the MOX facility would contain areas for support activities, including special nuclear material vault areas; general shipping and receiving docks; a general warehouse area; radioactive waste storage; assay facilities; emergency generators; heating, ventilation, and air-conditioning equipment; process gas and waste processing and treatment areas; the fuel rod fabrication area; and the fuel bundle assembly, storage, and shipping areas. Separate truck bays would be designed to accommodate the DOE SST/SGTs that would be used to transport the plutonium dioxide powder and the unirradiated fuel assemblies. Access control, office space, and warehouse facilities have been proposed for areas outside the secure MOX facility building. Facilities to support international or bilateral inspection and oversight activities would also be provided. Existing DOE site security and emergency services and environmental monitoring would support the MOX fuel fabrication mission.

MOX fuel is made from a mixture of plutonium dioxide and uranium dioxide. The uranium dioxide would be received from a commercial, NRC-licensed conversion facility. Conversion services for low-enriched uranium hexafluoride are commercially available in the United States at five facilities. As explained in Sections 2.4.4.2 and 2.4.4.3, for purposes of the analyses in this SPD EIS, the Portsmouth Gaseous Diffusion Plant near Piketon, Ohio, was analyzed as the representative facility for the source of depleted uranium hexafluoride to be converted into uranium dioxide.[13] An NRC-licensed commercial nuclear fuel fabrication facility in Wilmington, North Carolina, was used as a representative conversion facility.

2.4.3.2 MOX Fuel Fabrication Process

Figure 2–16 provides an overview of the MOX fuel fabrication process. The vast majority of the MOX fuel matrix, about 95 percent, is uranium dioxide. MOX fuel fabrication is essentially the same process that is used to produce low-enriched uranium fuel for commercial nuclear power reactors, once the plutonium and uranium dioxide powders are blended together into a mixed oxide. Processing of feed materials would begin with the plutonium-polishing process to remove gallium, but the process would also remove other impurities, including americium, aluminum, and fluorides. This process would include three elements: dissolution of the plutonium in nitric acid, removal of impurities by chemical separation (solvent extraction), and conversion of the plutonium back to an oxide powder by precipitation. Acid recovery steps, by which nearly all the nitric acid would be recovered and reused in the process, would also be included.

To begin the process, plutonium dioxide feedstock would be dissolved in near-boiling nitric acid with a silver nitrate catalyst. This solution would then be transferred to the solvent extraction process. Following solvent extraction, the plutonium would be converted from a nitrate solution back to an oxide powder through an oxalate precipitation, filtration, and calcination process. The resulting plutonium dioxide, verified to meet fabrication requirements, would then be transferred into containers for storage until needed, or transferred directly to the MOX fuel fabrication steps.

MOX fuel fabrication would begin with blending and milling the plutonium dioxide powder to ensure general consistency in enrichment and isotopic concentration. The uranium and plutonium powders would be blended and milled together to ensure uniform distribution of the plutonium in the MOX, and to adjust the particle size of the MOX powder. The MOX powder would then be made into pellets by pressing the powder into shape, sintering (baking at high temperature) the formed pellets, and grinding the sintered pellets to the proper

[13] In July 1999, DOE submitted its *Final Plan for the Conversion of Depleted Uranium Hexafluoride* to Congress and is finalizing a request for proposals for, among other depleted uranium hexafluoride management activities, construction and operation of a depleted uranium hexafluoride conversion facility at one or more gaseous diffusion plants.

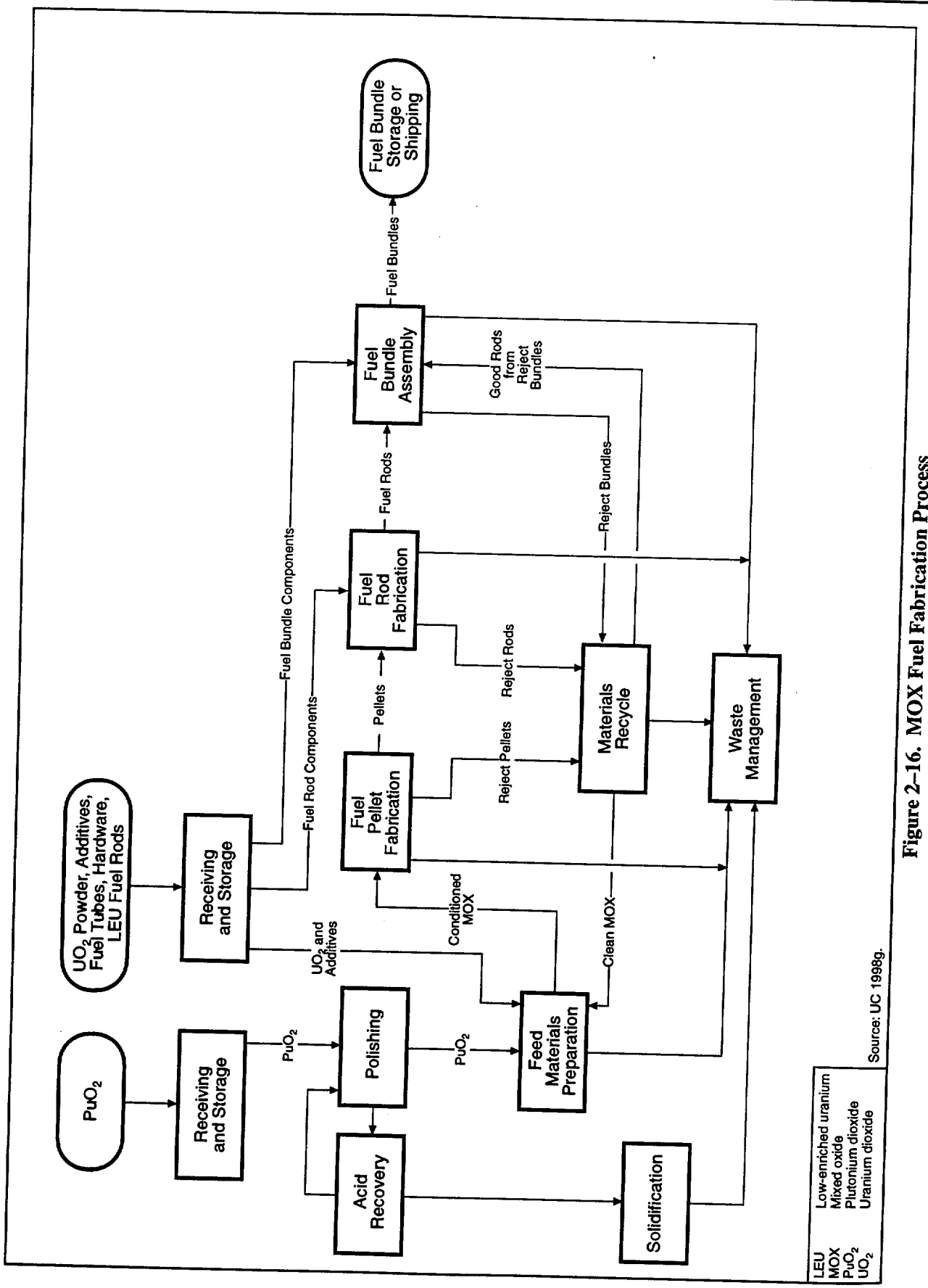


Figure 2–16. MOX Fuel Fabrication Process

dimensions. Materials and pellets would be inspected at each stage, and any rejected materials would be returned to the process for reuse. Most operations would be performed in sealed gloveboxes with inert atmospheres. Sintering furnaces would also be sealed, and offgases would be filtered and monitored prior to release to the atmosphere.

The finished pellets would be moved to the fuel rod fabrication area, where they would be loaded into empty rods. The rods would be sealed, inspected, and decontaminated, then bundled together to form fuel assemblies. Fuel assemblies would consist of only MOX rods or a mixture of MOX and low-enriched uranium rods. Low-enriched uranium rods used in fuel assembly fabrication would be fabricated at another of the fuel fabricator's facilities and brought to the MOX facility for final assembly with the MOX rods. Any rejected fuel bundles would be disassembled, and the materials recycled. Usable rods would be reassembled into new fuel assemblies. Pellets from rods not meeting final product specifications would be crushed and returned to the fabrication process, and decontaminated tubes and hardware would be recycled offsite as scrap metal. Storage for 2 years' production of fuel assemblies would be provided at the MOX facility. Individual fuel assemblies could be stored for that long prior to shipment to the designated domestic, commercial reactor, although production is anticipated to closely follow product need.

The plutonium-polishing process would produce aqueous waste containing the separated impurities (e.g., gallium, americium, aluminum, and fluorides). The liquid wastes from the various impurity removal processes would be transferred to a waste feed tank for evaporation and chemical treatment as required. The evaporator condensate would be treated to produce concentrated acid and acidified water for reuse. The evaporator concentrate would be chemically denitrated, and the offgas from the denitrator scrubbed to produce concentrated nitric acid for reuse. The impurities removed during these processes would be concentrated and solidified for disposal as TRU waste.

Solid wastes generated from process operations would include glovebox gloves, equipment, tools, wipes, and glovebox and HEPA filters. These materials would be removed from the process glovebox lines and transferred to a waste packaging glovebox. Nonprocess materials would be decontaminated to remove residual plutonium. The plutonium would be returned to the dissolution step, and the waste materials would be packaged, assayed, and disposed of as either TRU or LLW, as appropriate.

2.4.4 Transportation Activities

The plutonium disposition alternatives examined in this SPD EIS would require DOE to ship surplus plutonium-bearing materials from their current storage locations, shown in Figure 1–1, to the proposed disposition facility locations for processing. Table 2–3 is an overview of the different types of shipments that would be required for each proposed disposition facility and the vehicles in which the shipments would be made.

The overland transportation of any commodity involves a risk to both the transportation crew and members of the public. The risk results directly from transportation-related accidents and indirectly from the increased levels of pollution from vehicle emissions, regardless of the cargo. The transportation of hazardous or radioactive materials poses an additional risk due to the unique nature of the material being transported. Chapter 4 and Appendix L discuss the risks associated with the transportation of these materials and the steps that would be taken to mitigate these risks as they relate to this SPD EIS.

Table 2–3. Facility Transportation Requirements

Required Shipment	Vehicle[a, b]
Pit Conversion Facility	
Intersite shipment of surplus pits and clean metal to the pit conversion facility	SST/SGT
Recovered HEU from the pit conversion facility to ORR	SST/SGT
[Text deleted.]	
Plutonium dioxide to the immobilization or MOX facility	SST/SGT
Immobilization Facility	
Under Alternatives 11B and 12B, plutonium dioxide from the pit conversion facility[c]	SST/SGT
Surplus nonpit plutonium to the immobilization facility[d]	SST/SGT
Depleted uranium hexafluoride from one of DOE's sites at a gaseous diffusion plant to a conversion facility (ceramic immobilization option only)[e]	Commercial truck
Uranium dioxide from the conversion facility to the immobilization facility (ceramic immobilization option only)	Commercial truck
Immobilized plutonium from immobilization facility to the HLW vitrification facility (intrasite transport)	Special transport vehicle
Vitrified HLW with immobilized plutonium to a potential geologic repository	Commercial truck
MOX Facility[f]	
Under Alternatives 4 and 5, plutonium dioxide from the pit conversion facility[g]	SST/SGT
Depleted uranium hexafluoride from one of DOE's sites at a gaseous diffusion plant to a commercial conversion facility[e]	Commercial truck
Uranium dioxide from the conversion facility to the MOX facility	Commercial truck
Uranium fuel rods from a commercial fuel fabrication facility to the MOX facility[h]	Commercial truck
MOX fuel bundles to selected domestic, commercial reactors	SST/SGT
MOX spent fuel from domestic, commerical reactors to a potential geologic repository[i]	Commercial truck
Lead Assembly Fabrication Facility	
Plutonium dioxide from LANL to a lead assembly facility at a location other than LANL	SST/SGT
For lead assembly fabrication at LANL, intrasite movement of plutonium materials	Special transport vehicle
Depleted uranium hexafluoride from one of DOE's sites at a gaseous diffusion plant to a commercial conversion facility[e]	Commercial truck
Uranium dioxide from the conversion facility to the lead assembly facility	Commercial truck
Uranium fuel rods from a commercial fuel fabrication facility to the lead assembly facility	Commercial truck
MOX fuel bundles to the selected domestic, commercial reactor	SST/SGT
Irradiated lead assemblies or rods from the reactor to an examination site	Commerical truck
Spent fuel from an examination site to INEEL for storage[j]	Commercial truck
Spent fuel from INEEL to a potential geologic repository[i]	Commercial truck

[a] All containers and vehicles will meet Department of Transportation requirements.

[b] Commercial trucks will be driven by drivers certified to meet all radioactive materials transportation requirements.

[c] Under Alternatives 11A and 12A, the two facilities would be collocated; therefore, the transfer of the plutonium dioxide would not require any over-the-road transportation.

[d] For cases where the surplus nonpit plutonium requires offsite transportation.

[e] DOE is considering building one or more facilities at the gaseous diffusion plant(s) to convert depleted uranium hexafluoride to an oxide form.

[f] Some equipment for the MOX facility may be manufactured in Europe and shipped to the United States. No nuclear or radiologically contaminated materials would be transported. Any such shipments would be made by commercial vessel, and no impacts other than those occurring from routine commercial shipping would be expected.

[g] Under Alternatives 2, 3, 6A, 6B, 7, 8, 9, and 10, the two facilities would be collocated; therefore, the transfer of the plutonium dioxide would not require any over-the-road transportation.

[h] For cases where the fuel assemblies are a combination of MOX and low-enriched uranium fuel rods.

[i] Shipments of spent fuel are analyzed in the *Draft EIS for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*.

[j] Shipments of spent fuel within the DOE complex are analyzed in the *DOE Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final EIS*.

Key: HEU, highly enriched uranium; HLW, high-level waste; LANL, Los Alamos National Laboratory; ORR, Oak Ridge Reservation; SST/SGT, safe, secure trailer/SafeGuards Transport.

2.4.4.1 Pit Conversion Transportation Requirements

To implement any of the disposition alternatives being considered in this SPD EIS, clean plutonium metal and surplus pits would need to be shipped from current storage locations around the DOE complex to the proposed location of the pit conversion facility. Due to the attractiveness of these materials for use in constructing nuclear weapons, all intersite shipments would be made in DOE SST/SGTs.[14] In the alternatives that include locating the pit conversion facility at Pantex, where surplus pits are stored, the transfer of the surplus pits from onsite storage to the pit conversion facility would be made in specially designed transport vehicles that are routinely used to transport pits around the site. This would reduce the number of intersite trips and the distance that would have to be traveled to transport pits to the pit conversion facility. Also, as discussed in Appendix L, the dose associated with transferring the pits from storage to the pit conversion facility at Pantex could be reduced because the pits would be transferred from current storage locations to the pit conversion facility without being repackaged into the shipping containers that would be required for intersite transport.

After conversion, the plutonium from the pit conversion facility would be in the form of plutonium dioxide. For most of the alternatives, this material would be transferred from the pit conversion facility to either the immobilization or MOX facility through a secure underground tunnel. In Alternatives 6B and 11A, where the pit conversion facility is collocated in the same building with another disposition facility, the plutonium dioxide would be transferred within the building. However, several alternatives (4A, 4B, 5, 11B, and 12B) locate the pit conversion facility at Pantex and immobilization and/or MOX facilities at another site. The reason for including these alternatives is that the vast majority of the surplus pits are stored at Pantex. Less intersite transportation would be required to move these pits to the pit conversion facility, and the doses associated with repackaging pits into shipping containers at Pantex would be avoided. Under these alternatives, the plutonium dioxide from the pit conversion facility would be shipped in SST/SGTs to the other proposed disposition facilities.

HEU recovered during the pit disassembly process would be shipped via SST/SGT to ORR for declassification, storage, and eventual disposition.[15] The HEU would be decontaminated at the pit conversion facility, and would meet Y–12 acceptance criteria prior to shipment.

2.4.4.2 Immobilization Transportation Requirements

Figure 2–17 shows the transportation requirements for the proposed immobilization disposition activities. Surplus nonpit plutonium in various forms would be moved from current storage locations (i.e., Hanford, INEEL, LLNL, LANL, the Rocky Flats Environmental Technology Site [RFETS], and SRS) to the proposed immobilization facility location, either Hanford or SRS. The quantity of plutonium contained in these materials dictates that they be subjected to the same safeguards and security requirements as materials that could be used in nuclear weapons. Therefore, intersite shipments would be made in SST/SGTs.

---

[14] The SST/SGT is a specially designed component of an 18-wheel tractor-trailer vehicle. Although the details of the vehicle enhancements are classified, key characteristics are not, and include: enhanced structural supports and a highly reliable tie-down system to protect cargo from impact; heightened thermal resistance to protect the cargo in case of fire; deterrents to protect the unauthorized removal of cargo; couriers who are armed federal officers and receive rigorous training and are closely monitored through DOE's Personnel Assurance Program; an armored tractor to protect the crew from attack and advanced communications equipment; specially designed escort vehicles containing advance communications and additional couriers; 24-hr-a-day real-time monitoring of the location and status of the vehicle; and significantly more stringent maintenance standards.

[15] Shipments would be in accordance with 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; FONSI, September 1995). Storage would be in accordance with the ROD for the *Storage and Disposition PEIS*; disposition would be in accordance with the ROD for the *Disposition of Surplus Highly Enriched Uranium Final Environmental Impact Statement* (61 FR 40619, August 5, 1996).

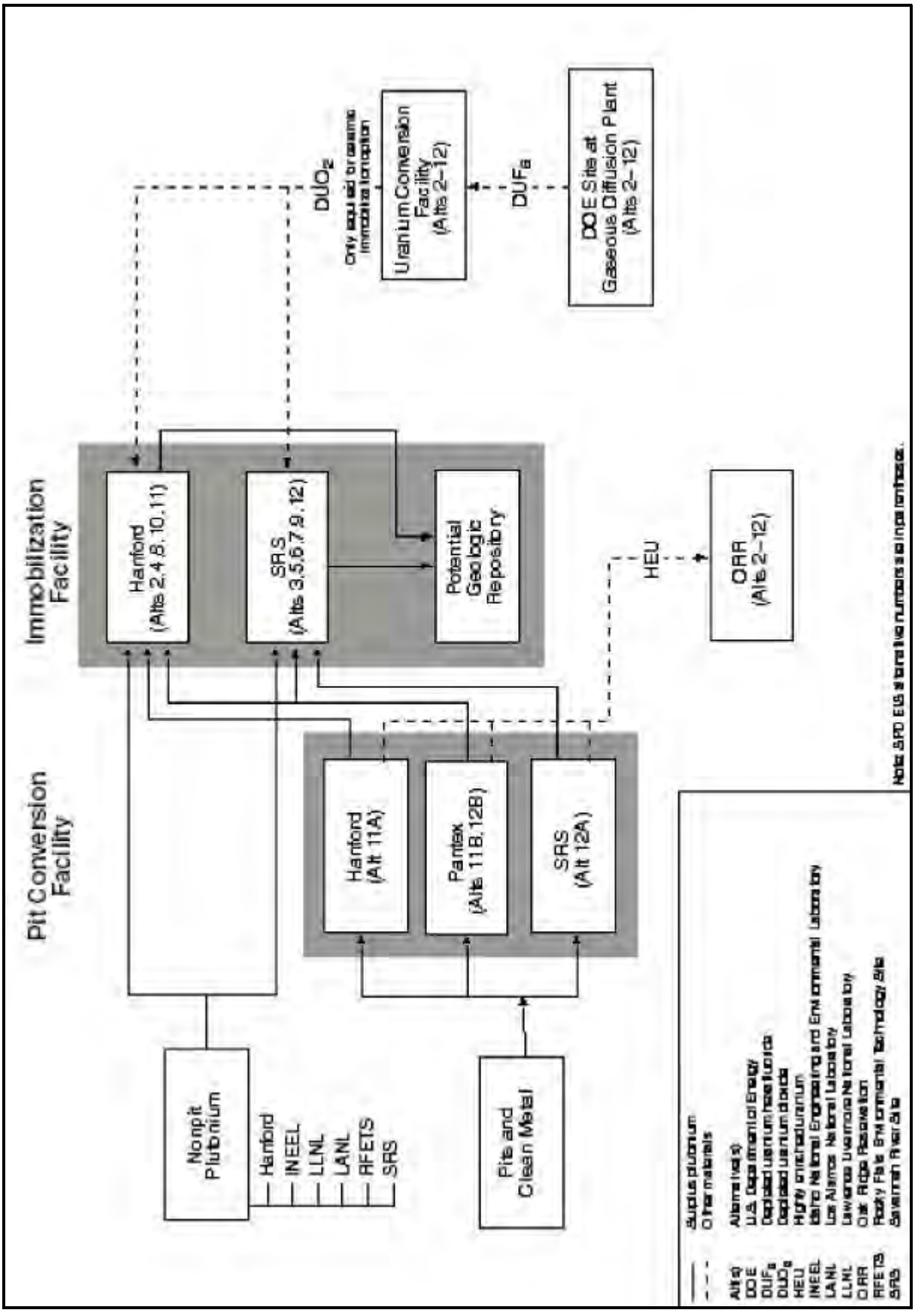


Figure 2–17. Transportation Requirements for Plutonium Conversion and Immobilization

For Alternatives 11 and 12, where all the surplus plutonium would be immobilized, the plutonium dioxide from the pit conversion facility would also be transferred to the immobilization facility. For Alternative 11A, both facilities would be collocated in FMEF and the transfer would take place within the same building. For Alternative 12A, the transfer would be made between the two facilities at SRS through a secure underground tunnel and would not require any vehicular transportation. [Text deleted.] However, as discussed in Section 2.4.4.1, for Alternatives 11B and 12B, the plutonium dioxide would be shipped from the pit conversion facility at Pantex to the immobilization facility at either Hanford or SRS in SST/SGTs.

Surplus plutonium destined for immobilization would be immobilized in either a ceramic or glass form, placed in small stainless steel cans and then into HLW canisters at the immobilization facility. The canisters would then be transported in specially designed intrasite transport vehicles to an HLW vitrification facility (either DWPF at SRS, or the planned HLW vitrification facility at Hanford). In keeping with the current practice at these sites for this type of shipment, this intrasite transportation could require roads at Hanford or SRS to be closed temporarily while the material would be transported from one area of the site to another. This practice would provide all needed security measures and mitigate potential risk to the public, without requiring the use of SST/SGTs for intrasite transfers.

Immobilization alternatives at Hanford could involve the transfer of plutonium between FMEF and the immobilization annex. This transfer would occur either through an underground tunnel or by surface vehicle within the protected security zone.

Immobilization of the plutonium as a ceramic material also requires a small amount of depleted uranium dioxide (i.e., less than 10 t/yr [11 tons/yr]) as discussed in Section 2.4.2.2.2. This depleted uranium dioxide could be produced by shipping depleted uranium hexafluoride from one of DOE's storage areas at a gaseous diffusion plant in Kentucky, Ohio, or Tennessee via commercial truck to a commercial site for conversion to depleted uranium dioxide. Possible sites for this conversion include nuclear fuel fabrication facilities in Missouri, North Carolina, South Carolina, or Washington, or a uranium conversion facility in Illinois. After conversion at one of these sites, the uranium dioxide would be shipped on a commercial truck to either Hanford or SRS for use in the immobilization facility. Because the risks associated with transporting either depleted uranium hexafluoride or depleted uranium dioxide are extremely low, the shipments could be made to or from any of the locations discussed above and not significantly affect the overall risks associated with the transportation required in this SPD EIS. For the purposes of quantifying the transportation analysis in this SPD EIS, it was assumed that the depleted uranium hexafluoride would be shipped from the DOE facility at the Portsmouth Gaseous Diffusion Plant near Piketon, Ohio, to an NRC-licensed commercial nuclear fuel fabrication facility in Wilmington, North Carolina, for conversion.

After the immobilized plutonium would be encased by HLW at the HLW vitrification facility, it would eventually be shipped to a potential geologic repository for ultimate disposal. Because the cans of immobilized plutonium would displace some of the HLW that would otherwise fill the canister, additional canisters would have to be filled over the life of the immobilization program to address this displaced HLW. It is estimated that up to 395 additional canisters of HLW would result from the decision to immobilize all 50 t (55 tons) of surplus plutonium. The *Draft Environmental Impact Statement for* a *Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada* (*Yucca Mountain Draft EIS*), (DOE 1999b) analyzed a number of different options for the shipment of these canisters using either trucks or trains. The analysis in the *Yucca Mountain Draft EIS* indicated that the risks would be lower if the canisters were shipped by train. However, no ROD has been issued regarding these shipments. To bound the risks, this SPD EIS has taken the most conservative analytical approach (i.e., the approach that results in the highest risk to the public) and assumed that all of these shipments would be made by truck to the potential geologic repository, with one canister being loaded on each truck.

2.4.4.3 MOX Transportation Requirements

To implement the MOX disposition alternatives being considered in this SPD EIS, plutonium dioxide from the pit conversion facility would have to be transferred to the MOX facility. Under all the MOX alternatives except Alternatives 4A, 4B, and 5, the pit conversion and MOX facilities would be located at the same site. Figure 2–18 shows the transportation requirements for the proposed MOX disposition activities. ForAlternative 6B, the transfer would take place within the same building (FMEF). Under Alternatives 2, 3, 6A, 7 , 8, 9, and 10, current designs assume that facility materials would be transferred between the two facilities through a secure, underground tunnel. No vehicular transportation over public roads would be required for any of these alternatives. However, as discussed in Section 2.4.4.1, for Alternatives 4A, 4B, and 5, the plutonium dioxide would be shipped in SST/SGTs from the pit conversion facility at Pantex to the MOX facility at either Hanford or SRS.

MOX fuel fabrication also requires uranium dioxide. Depleted uranium dioxide could be produced by shipping depleted uranium hexafluoride from one of DOE's storage areas at a gaseous diffusion plant in Kentucky, Ohio, or Tennessee via commercial truck to a commercial site for conversion to depleted uranium dioxide. Possible sites for this conversion include nuclear fuel fabrication facilities in Missouri, North Carolina, South Carolina, or Washington, or a uranium conversion facility in Illinois. After conversion at one of these sites, the uranium dioxide would be shipped on a commercial truck to Hanford, INEEL, Pantex, or SRS for use in the MOX facility. Because the radiological risks associated with transporting either depleted uranium hexafluoride or depleted uranium dioxide are extremely low, the shipments could be made from or to any of the locations discussed above and not significantly change the overall risks associated with the transportation required in this SPD EIS. For the purposes of quantifying the transportation analysis in this SPD EIS, representative sites for obtaining the depleted uranium dioxide were chosen. The Portsmouth Gaseous Diffusion Plant near Piketon, Ohio, represents the source of the depleted uranium hexafluoride and an NRC-licensed commercial nuclear fuel fabrication facility in Wilmington, North Carolina, represents the conversion facility.

After conversion, the depleted uranium dioxide would be shipped on a commercial truck from the conversion facility to the MOX facility. After fabrication, the MOX fuel would be shipped to Catawba, McGuire, or North Anna where it would be inserted into the reactor and irradiated. These shipments would be made in SST/SGTs because unirradiated MOX fuel in large enough quantities is subject to security concerns similar to those associated with weapons-grade plutonium. [Text deleted.]

It is also possible that some equipment for the MOX facility may be manufactured in Europe and shipped to the United States. No nuclear or radiologically contaminated materials would be transported. Any such shipments would be made by commercial vessel, and no impacts other than those occurring from routine commercial shipping would be expected.

2.4.4.4 Lead Assembly and Postirradiation Examination Transportation Requirements

To implement the MOX disposition alternatives being considered in this SPD EIS, MOX fuel assemblies would be fabricated, irradiated, and tested before the actual production of MOX fuel. Figure 2–19 shows the transportation requirements for the proposed lead assembly activities. As described in Section 2.17, plutonium dioxide from the Pit Disassembly and Conversion Demonstration Project at LANL would be shipped in SST/SGTs to one of four candidate DOE facilities (Hanford, ANL–W, LLNL, or SRS), or remain at LANL, for fabrication into lead assemblies. If the lead assemblies were to be fabricated at LANL, the plutonium dioxide would be transferred from the pit conversion demonstration to the lead assembly fabrication area within the same plutonium processing building (PF–4), in Technical Area 55 (TA–55), for MOX pellet production. Any intrasite transfers of plutonium outside of TA–55 would be in special vehicles in accordance

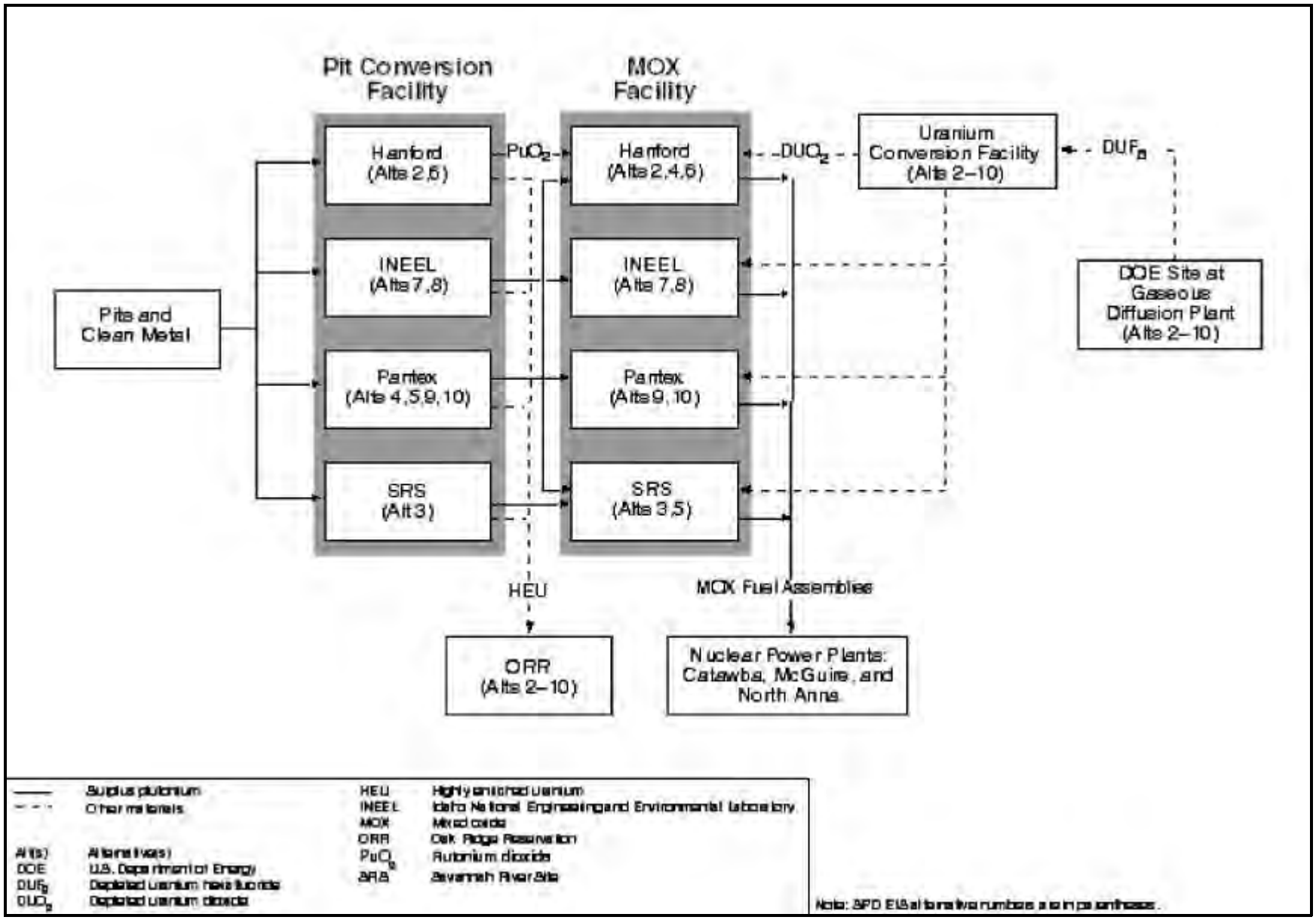


Figure 2–18. Transportation Requirements for MOX Fuel Fabrication

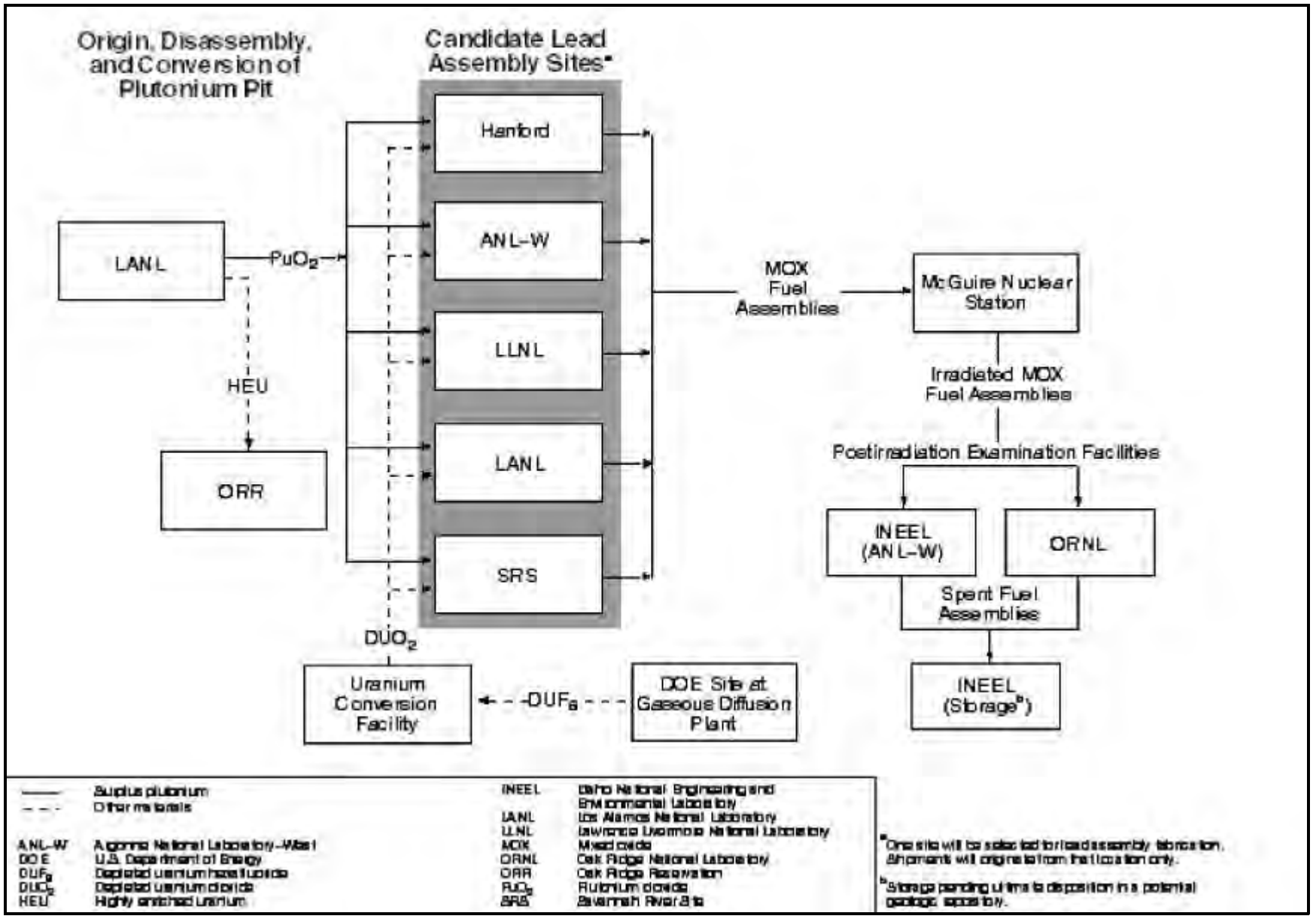


Figure 2–19. Transportation Requirements for Lead Assembly Fabrication

with site practices for this type of shipment. This intrasite transportation could require temporary road closures while the material would be moved from one area of the site to another. This practice would provide all needed security and mitigate potential risk to the public, without requiring the use of SST/SGTs for intrasite transfers.

The depleted uranium needed to support this effort is assumed to be shipped from one of DOE's storage areas at the Portsmouth Gaseous Diffusion Plant near Piketon, Ohio, to the nuclear fuel fabrication facility in Wilmington, North Carolina, for conversion, and then to the lead assembly fabrication site. All the transportation associated with depleted uranium would be via commercial truck.

After fabrication, the lead assemblies would be shipped to McGuire Nuclear Station[16] near Huntersville, North Carolina, for irradiation. These shipments would be made in SST/SGTs because unirradiated MOX fuel in large enough quantities is subject to security concerns similar to those associated with weapons-grade plutonium. Although the Preferred Alternative would fabricate lead assemblies at LANL, the lead assemblies could be fabricated as far away from McGuire as Hanford. Because transportation impacts are proportional to distance, the transportation analysis assumes, in order to evaluate the maximum potential impact, that the reactor will be 5,000 km (3,100 mi) from the lead assembly fabrication facility, the approximate distance between Hanford and McGuire. Transportation impacts would be proportionally less for other sites closer to McGuire.

After irradiation, the lead assemblies may be shipped from the reactor site to a postirradiation examination facility for analysis. Postirradiation examination, if required, would occur at one of two DOE sites, ANL–W or ORNL. As discussed in Section 2.1.3, these are the only two sites that have the capability to conduct postirradiation examination without major modifications to facility and processing capabilities. These shipments would be via commercial truck because the MOX fuel would be irradiated, thereby removing the proliferation concerns associated with plutonium. Because the actual postirradiation facility that would be used has not been selected (ORNL has been identified as the preferred location), the transportation analysis assumes that it will be 4,000 km (2,500 mi) from the reactor site where the lead assemblies were irradiated. This is the approximate distance between McGuire and ANL–W, the maximum distance that the irradiated lead assemblies would be transported. Any postirradiation examination activities and shipments of spent fuel remaining after postirradiation examination would comply with the Consent Order and Settlement Agreement in Public Service Company of Colorado v. Batt and all other applicable agreements and orders, including provisions concerning removal of the material from the applicable examination site and limits on the number of truck shipments to the site.

2.4.4.5 Other Transportation Requirements

All the alternatives being considered in this SPD EIS require some overland transportation of wastes from the proposed disposition facilities to treatment, storage, or disposal facilities. The proposed action does not result in a large increase in waste generation at any of the candidate sites, and transportation would be handled in the same manner as other site waste shipments. In addition, the shipments would not represent any new, different, or additional risks beyond those associated with existing waste shipments at these sites, as analyzed in the WM PEIS. The possible exceptions are the alternatives that consider siting disposition facilities at Pantex and the alternative that considers placing the lead assembly fabrication facility at LLNL. Because Pantex does not currently generate any TRU waste and does not have any TRU waste in storage, the WM PEIS did not consider TRU waste being shipped from Pantex to the Waste Isolation Pilot Plant (WIPP). Therefore, a small number of shipments of TRU waste to WIPP via commercial truck have been included in the transportation analysis in this SPD EIS. In addition, the projected amount of LLW generated by the proposed action would represent a large percentage of this waste type at both Pantex and LLNL, as analyzed in the WM PEIS. Because these sites ship

[16] Based on information provided by DCS, DOE has identified McGuire as its preference for irradiating lead assemblies.

LLW to the Nevada Test Site (NTS) for disposal, the transportation analysis in this SPD EIS includes a small number of shipments of LLW from Pantex and LLNL to NTS via commercial carrier.

2.5 ALTERNATIVE 1: NO ACTION

In the No Action Alternative, surplus weapons-usable plutonium materials in storage at various DOE sites shown in Figure 1–1 would remain at those locations. The vast majority of pits would continue to be stored at Pantex, and the remaining plutonium in various forms would continue to be stored at Hanford, INEEL, LLNL, LANL, RFETS, and SRS. The No Action Alternative would not satisfy the purpose and need for the proposed action because DOE's disposition decisions in the *Storage and Disposition PEIS* ROD would not be implemented. The ROD announced that, consistent with the Preferred Alternative in the *Storage and Disposition PEIS*, DOE had decided to reduce, over time, the number of locations where the various forms of plutonium are stored, through a combination of storage and disposition alternatives. Implementation of much of this decision requires the movement of surplus materials to disposition facility locations. Pits that have been moved from RFETS to Pantex would be relocated in accordance with the *Storage and Disposition PEIS* ROD, as amended.[17] Other surplus materials would continue to be stored indefinitely at their current locations, with the exception that DOE is considering leaving the repackaged surplus pits in Zone 4 at Pantex for long-term storage.[18] An appropriate environmental review will be conducted when the specific proposal for this change has been determined (e.g., whether additional magazines need to be air-conditioned). The analysis in this SPD EIS assumes that the surplus pits are stored in Zone 12 in accordance with the ROD for the *Storage and Disposition PEIS*.

2.6 ALTERNATIVE 2: ALL FACILITIES AT HANFORD

Pit Conversion in FMEF; Immobilization in FMEF and the HLW Vitrification Facility; MOX Fuel Fabrication in New Construction

This alternative would involve locating the three proposed surplus plutonium disposition facilities in the 400 Area at Hanford, combining the use of an existing building, FMEF, with new construction (see Figure 2–20). Canister filling would be accomplished at the planned HLW vitrification facility in the 200 East Area[19] (see Figure 2–21), about 24 km (15 mi) northwest of the 400 Area. FMEF, completed in 1984, is a reinforced concrete process building with an attached mechanical equipment wing on the west side, and an entry wing with administrative space across the south side. The building has six levels, two of which are below grade. FMEF was designed and constructed to fabricate fast breeder reactor fuel, but it has not been used for any major projects to date. The building has been modified since 1984, and the utility systems and support systems, including the ventilation system, have been completed. Designed to handle highly radioactive materials, FMEF includes a number of thick-walled cells surrounded by corridors. Space for offices,

[17] Recent studies have indicated that cost savings could be realized from the transfer of nonpit materials from RFETS and Hanford to SRS earlier than specified in the *Storage and Disposition PEIS* ROD. A Supplement Analysis was prepared, and based on this analysis, DOE determined that a supplemental PEIS would not be needed; an amended ROD was issued in August 1998 (63 FR 43386) and included decisions to accelerate shipment of all nonpit surplus plutonium from RFETS to SRS and to relocate all Hanford surplus plutonium to SRS, should SRS be selected as the immobilization disposition site.

[18] Should the No Action Alternative be chosen, the ROD pursuant to this SPD EIS would also address movement of the remaining surplus nonpit plutonium from RFETS in support of its planned closure in 2006.

[19] The planned HLW vitrification facility is described in the *Tank Waste Remediation System Final Environmental Impact Statement* and is currently scheduled to be available in a timeframe that would meet the needs of the surplus plutonium disposition program.

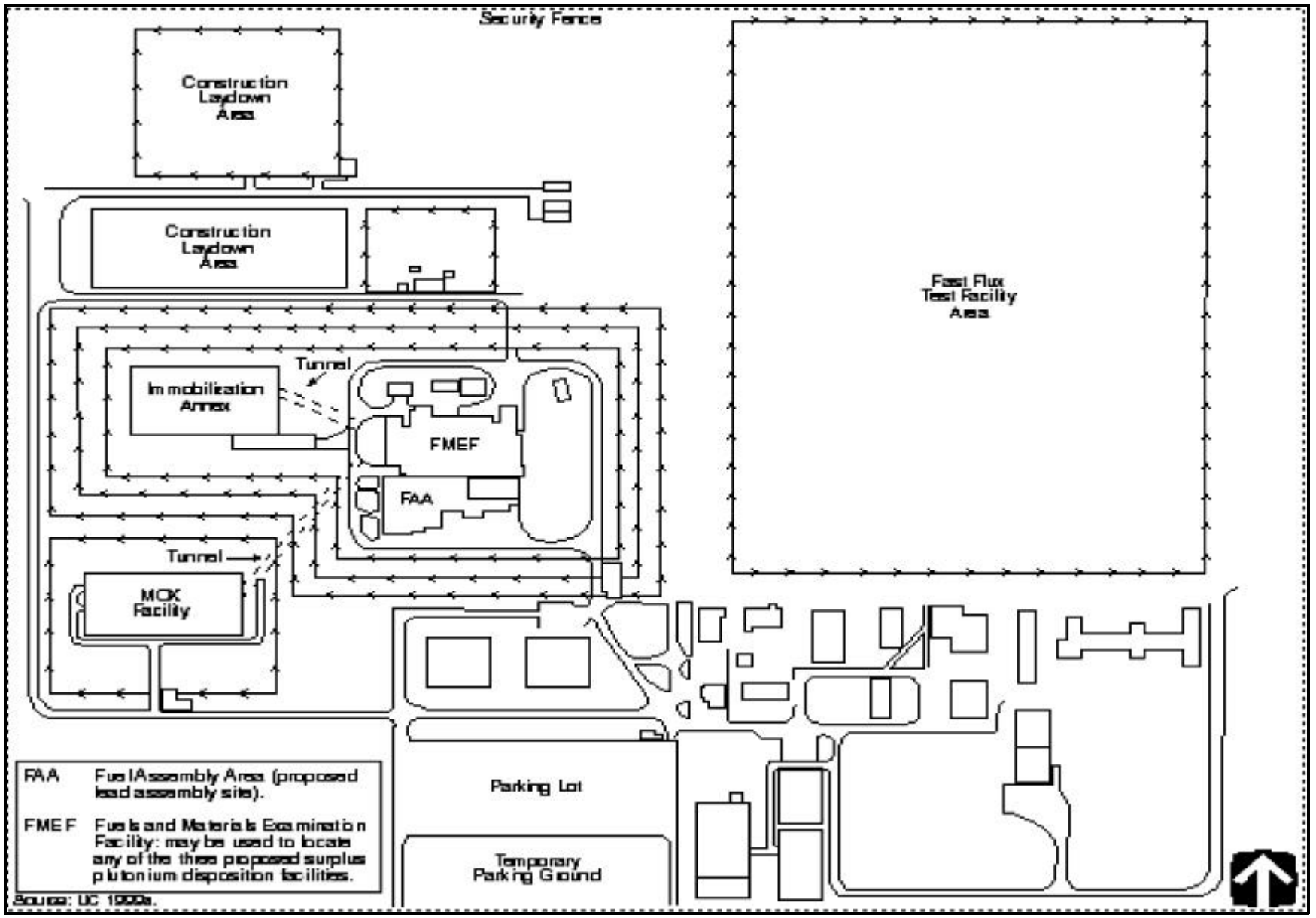


Figure 2–20. Proposed Facility Locations in the 400 H-Area at Hanford (Hybrid Alternative Shown)

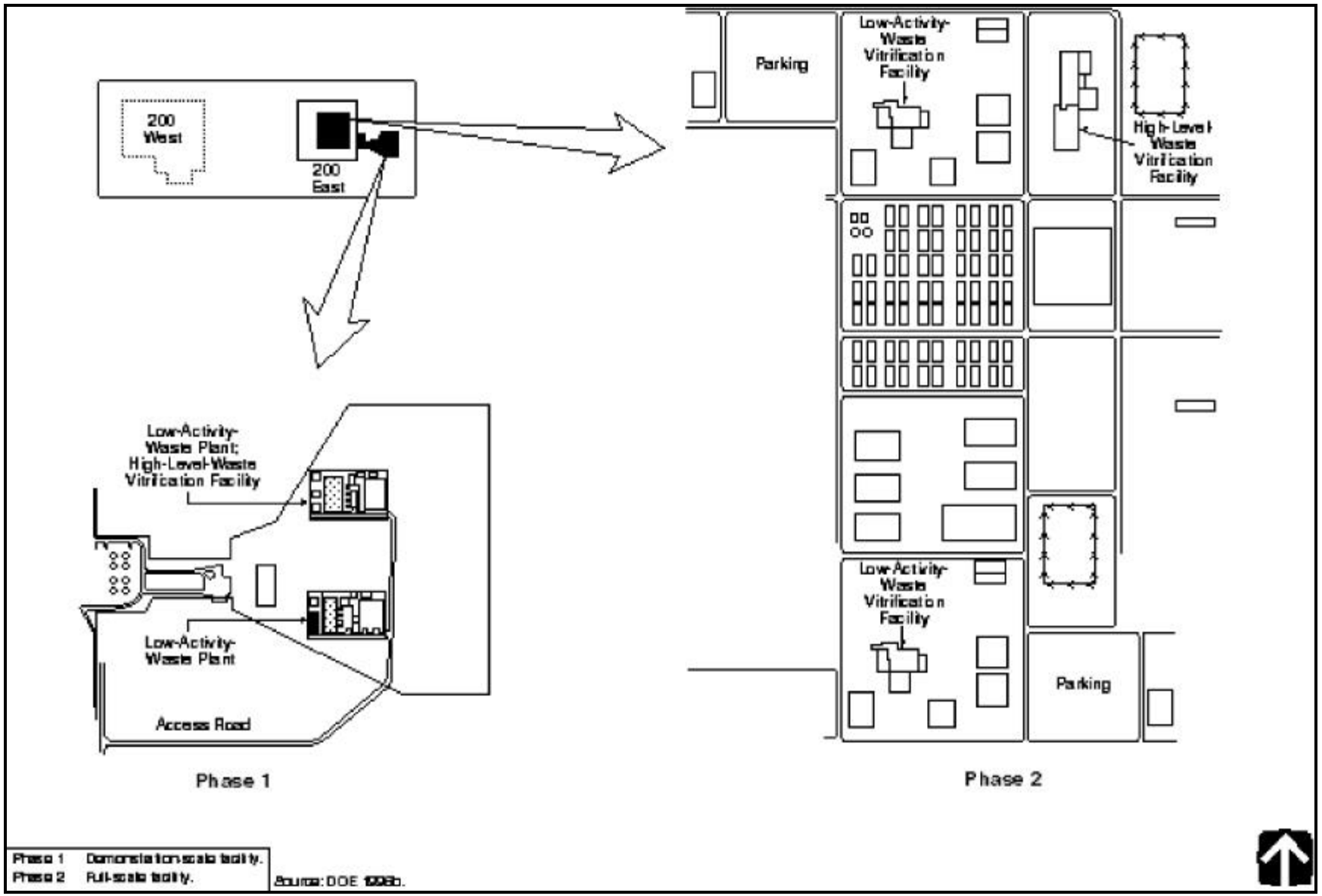


Figure 2–21. Location of Planned HLW Vitrification Facility in the 200 Area at Hanford (Proposed Location of Canister-Filling Operations)

laboratories, control rooms, utilities, and other activities is available around the interior perimeter of the building. Modification to the interior spaces would be required to use the building for surplus plutonium disposition activities. No radioactive materials have been introduced into the building, so the modification would neither generate radioactive waste nor contribute radiological dose to the construction workforce. The building is large enough to house facilities for only two of the three proposed disposition activities. Therefore, this alternative calls for collocation of the pit conversion and immobilization facilities in FMEF, and the construction of a new building close to FMEF to house the MOX facility.

In this alternative, the pit conversion facility would occupy the lower floors of FMEF, and the immobilization facility, the upper two floors. About 13,000 m^2 (140,000 ft^2) of space on the −35-ft, −17-ft, ground, and +21-ft levels would be modified to support pit disassembly and conversion activities. Not all the space on every floor would be required for pit disassembly and conversion activities, but the floors would be predominately associated with that process.

Plutonium conversion and immobilization activities would primarily occupy the +42- and +70-ft levels. While a portion of the +42-ft level would be shared by the two facilities, most of the floor would be dedicated to the immobilization facility, which would occupy about 17,000 m^2 (183,000 ft^2). Both facilities would share utilities, loading docks, and security assets. The large shipping and receiving area of FMEF would allow for housing a number of SST/SGTs.

The immobilization facility would also require the construction of a two-story annex northwest of FMEF. This building would provide approximately 4,600 m^2 (49,000 ft^2) of space for canister-loading activities and some analytical laboratory operations. The security fence surrounding FMEF would be extended to include this additional area. Material movement between FMEF and the annex would occur either by surface vehicle or through an underground tunnel between the two facilities within the protected security zone.

For the MOX facility, a new two-story building of about 20,000 m^2 (215,000 ft^2) would be constructed west of FMEF. A secure underground tunnel would connect the two buildings for special nuclear material transfers. This tunnel would be locked and alarmed under normal operating conditions and subject to the same security measures on both sides as the building perimeters, both to ensure the protection of the special nuclear materials and to maintain the independence of the MOX facility. The tunnel would be opened in accordance with safeguards and security procedures for the transfer of plutonium dioxide from the pit conversion facility to the MOX facility, and would be closed immediately upon completion of transfer activities. Other than being joined to it by this tunnel, the MOX facility would be independent of FMEF, and would be inside its own fenced security area. Various nonhardened support buildings totaling about 2,300 m^2 (25,000 ft^2) would be needed to support the MOX mission. The proposed facilities would use such existing Hanford services as sitewide security (although there would be additional security assigned to each of the three disposition facilities), emergency services, environmental monitoring, and waste management.

Construction would begin in about 2001, with modifications to FMEF for the pit conversion facility, and would continue through completion of the MOX facility in about 2006. Operations would commence in about 2004 with pit disassembly and conversion, and would continue until about 2019 when the MOX and immobilization facilities have completed their missions. Operation of the MOX facility would not begin until the pit conversion facility had been operating for a year, so that feed material would be available for MOX fuel fabrication.

2.7 ALTERNATIVE 3: ALL FACILITIES AT SRS

Pit Conversion and MOX Fuel Fabrication in New Construction; Immobilization in New Construction and DWPF

2.7.1 [Section heading deleted.]

This alternative would involve locating the three proposed surplus plutonium disposition facilities in newly constructed buildings near the area currently designated for APSF in F-Area at SRS (see Figure 2–22). In addition, the canister receipt area at DWPF in S-Area, about 6 km (3.7 mi) east of F-Area (see Figures 2–5 and 2–23), would be modified as described in Section 2.4.2.1 to accommodate receipt and processing of the canisters transferred from the immobilization facility for filling with vitrified HLW. [Text deleted.]

In the SPD Draft EIS, alternatives that considered locating the disposition facilities in new construction at SRS used the proposed APSF as a receiving facility for SST/SGT shipments; storage vaults for plutonium dioxide and metal; and for the pit conversion and immobilization facilities, nondestructive assay facilities. Therefore, the SPD Draft EIS analyzed somewhat smaller disposition facilities at SRS than at the other candidate sites. DOE has recently decided to delay the construction of APSF. Because the schedule for APSF is uncertain, this SPD Final EIS has been modified to disregard any benefit to the proposed facilities as a result of APSF being present at SRS. This SPD EIS now presents the environmental impacts that would be associated with construction and operation of disposition facilities at SRS that are stand-alone and include no reliance on APSF for storage space or other functions. Throughout this SPD EIS, references to APSF have been qualified by the phrase "if built" or a similar phrase, and no credit has been taken in the environmental analyses for the use of APSF.

The pit conversion facility now analyzed at SRS is identical to that proposed in the Pantex alternatives, where it has always been considered a stand-alone facility. In the current immobilization facility design, some space would be available to partially offset the use of APSF for functions such as storage or accountability measurements. However, without APSF, construction of truck bays and other minor modifications (up to approximately 980 m^2 [10,500 ft^2]) would be necessary. The MOX facility proposed for SRS has also been replaced with the larger stand-alone facility that has been proposed for the other candidate sites. Should DOE decide to collocate all three disposition facilities at SRS, as indicated in the Preferred Alternative (see Section 1.6), the final design of these facilities would coordinate potential common functions among the facilities to the extent practical as a means to reduce space requirements and the associated environmental impacts.

As shown in Figure 2–22, the immobilization facility would be east of the area currently designated for APSF, the pit conversion facility due south of the immobilization facility, and the MOX facility due south of the pit conversion facility.[20] To accommodate all three disposition facilities at this location, it would be necessary to move the F-Area fence line to incorporate more area. These facilities would be connected to each other by material transfer tunnels. These tunnels would be locked and alarmed under normal operating conditions and subject to the same security measures on both sides as the building perimeters, both to ensure the protection of the special nuclear materials and to maintain the independence of the MOX facility. The tunnels would be opened in accordance with safeguards and security procedures for the transfer of special nuclear materials and would be closed immediately upon completion of transfer activities. Other than being joined by the tunnel, the MOX

[20] As discussed in Section 4.26.4.4.1, facility construction would avoid any cultural resource areas eligible or potentially eligible for nomination to the National Register of Historic Places.

facility would be independent of the other plutonium disposition facilities and would be inside its own fenced security area.

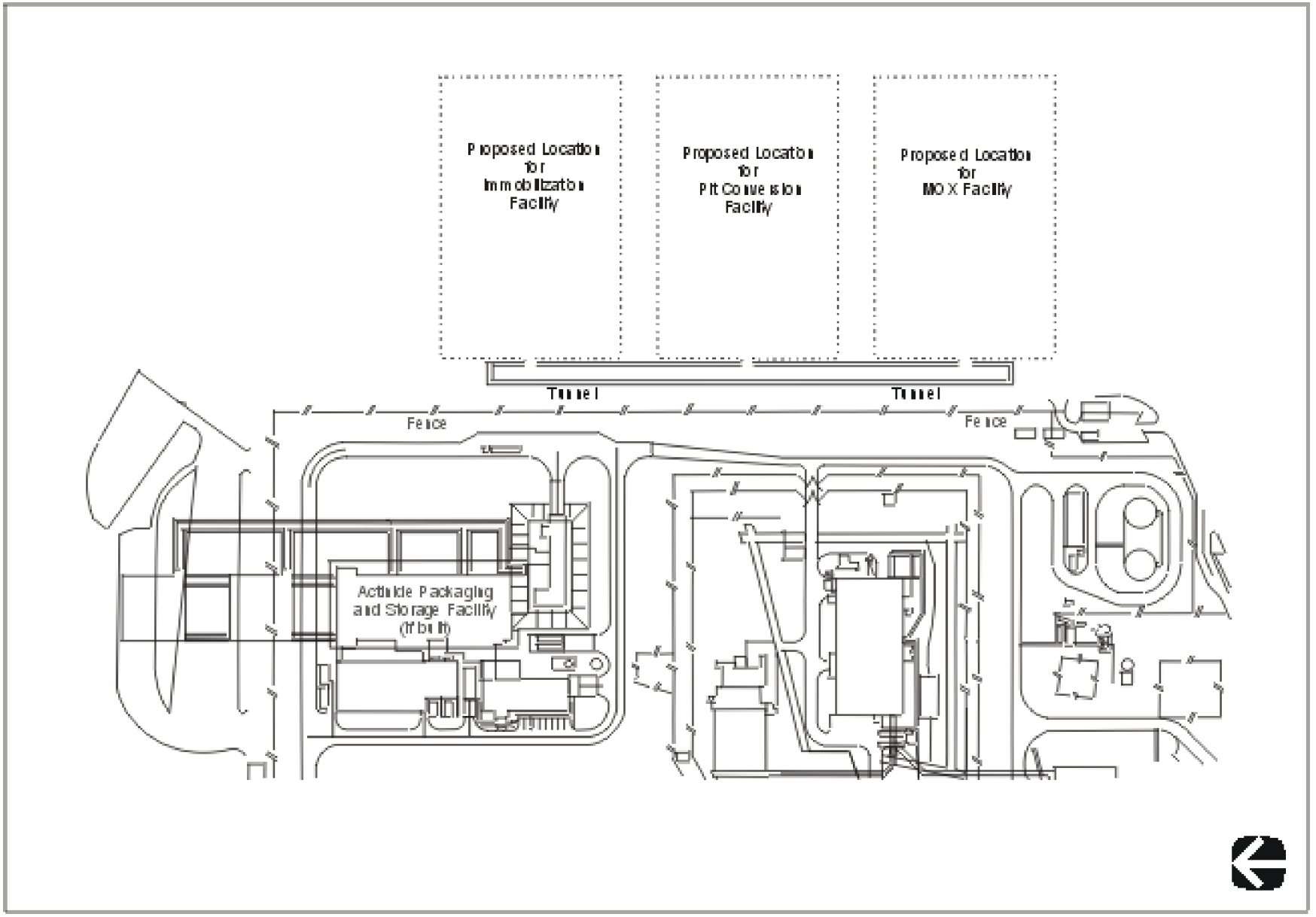


Figure 2–22. Proposed Facility Locations in F-Area at SRS

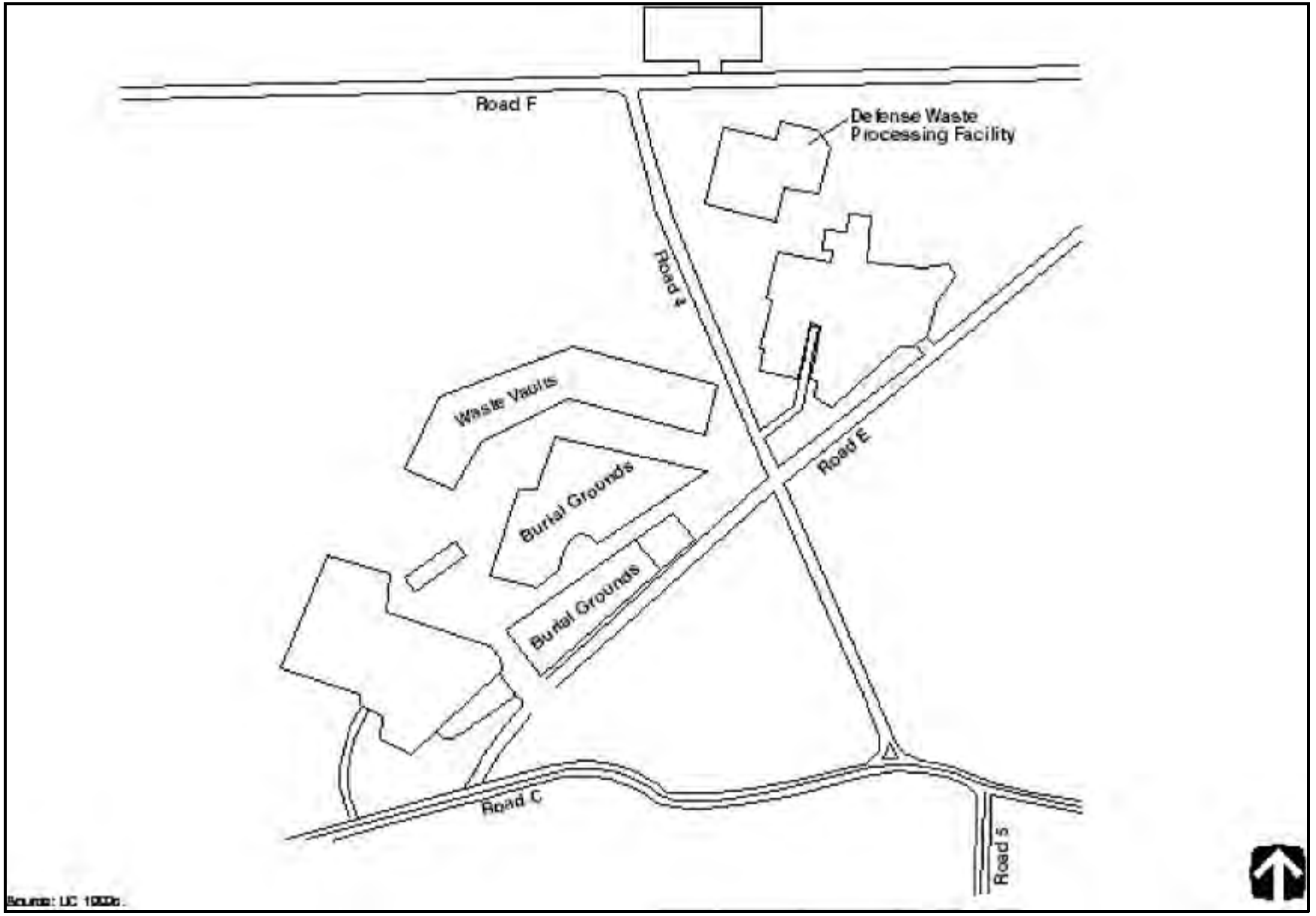


Figure 2–23. Location of DWPF in S-Area at SRS (Proposed Location of Canister-Filling Operations)

The pit conversion facility would occupy about 18,600 m^2 (200,000 ft^2) on two levels, one or both of which may be below grade. Another 2,400 m^2 (26,000 ft^2) would be required for a utility building, standby generator, and an electrical substation in F-Area. The total space required for the immobilization facility would be about 25,000 m^2 (269,000 ft^2). Of that, 23,000 m^2 (248,000 ft^2) would be in new facilities in F-Area; the remainder would be space in existing facilities that would not require further modification. The immobilization facility would have four levels, three of which would be above grade. The main process area would be at grade level, below which a small basement level would contain transfer corridors and a fire-water collection facility. The third level would house support equipment such as heating, ventilation, and air-conditioning systems, and electrical and mechanical utilities. In the center of the facility, a core "stack" or shaft would extend from the main processing level up to the small fourth level for vertical processing of materials. Two smaller, two-level structures immediately adjacent and connected to the main processing building would serve as entry control and provide administrative space. The MOX facility would occupy about 20,000 m^2 (215,000 ft^2) on two levels, one below grade. Another 2,300 m^2 (25,000 ft^2) would be required for new support buildings in F-Area. The proposed facilities would use such existing SRS services as sitewide security (although there would be additional security assigned to each of the three disposition facilities), emergency services, environmental monitoring, and waste management.

Construction would commence in about 2001 with the pit conversion facility, and would continue through completion of the MOX facility in about 2006. Operations would commence in about 2004 with pit conversion, and would continue until about 2019, when the MOX and immobilization facilities have completed their missions. Operation of the MOX facility would not begin until the pit conversion facility had been operating for a year, so that feed material would be available for MOX fuel fabrication.

2.7.2 [Section deleted because alternative deleted.]

2.8 ALTERNATIVE 4: PIT CONVERSION AT PANTEX; MOX FUEL FABRICATION AND IMMOBILIZATION AT HANFORD

2.8.1 Alternative 4A

Pantex: Pit Conversion in New Construction
Hanford: MOX Fuel Fabrication in New Construction; Immobilization in FMEF and HLW Vitrification Facility

This alternative would involve locating the pit conversion facility at Pantex and the immobilization and MOX facilities at Hanford. The pit conversion and MOX facilities would be in new construction, and FMEF would be modified to house the immobilization facility. Canister filling would be accomplished at the planned HLW vitrification facility scheduled for construction in the 200 East Area, about 24 km (15 mi) northwest of the 400 Area (see Figures 2–20 and 2–21).

At Pantex, the pit conversion facility would be in a new building in Zone 4 West, with some support facilities to the west of, and adjacent to, Zone 4 West (see Figure 2–24). Utilities and storage vaults would be on the ground floor of the pit conversion facility; and the main processing and loading areas, offices, and support areas, in a below-grade basement. The building would occupy about 18,600 m^2 (200,000 ft^2). New buildings totaling 5,300 m^2 (57,000 ft^2) would have to be constructed to support the pit conversion facility. Additional space in existing buildings in Zone 4 West would be used for administration, access control, warehousing, and other services. New or upgraded electrical, water, and gas supply lines would be constructed from existing trunk lines. The proposed pit conversion facility would use such existing Pantex services as sitewide security (although there would be an additional security assigned to the facility), emergency services, environmental monitoring, and waste management. TRU waste storage would be provided in the main pit conversion facility

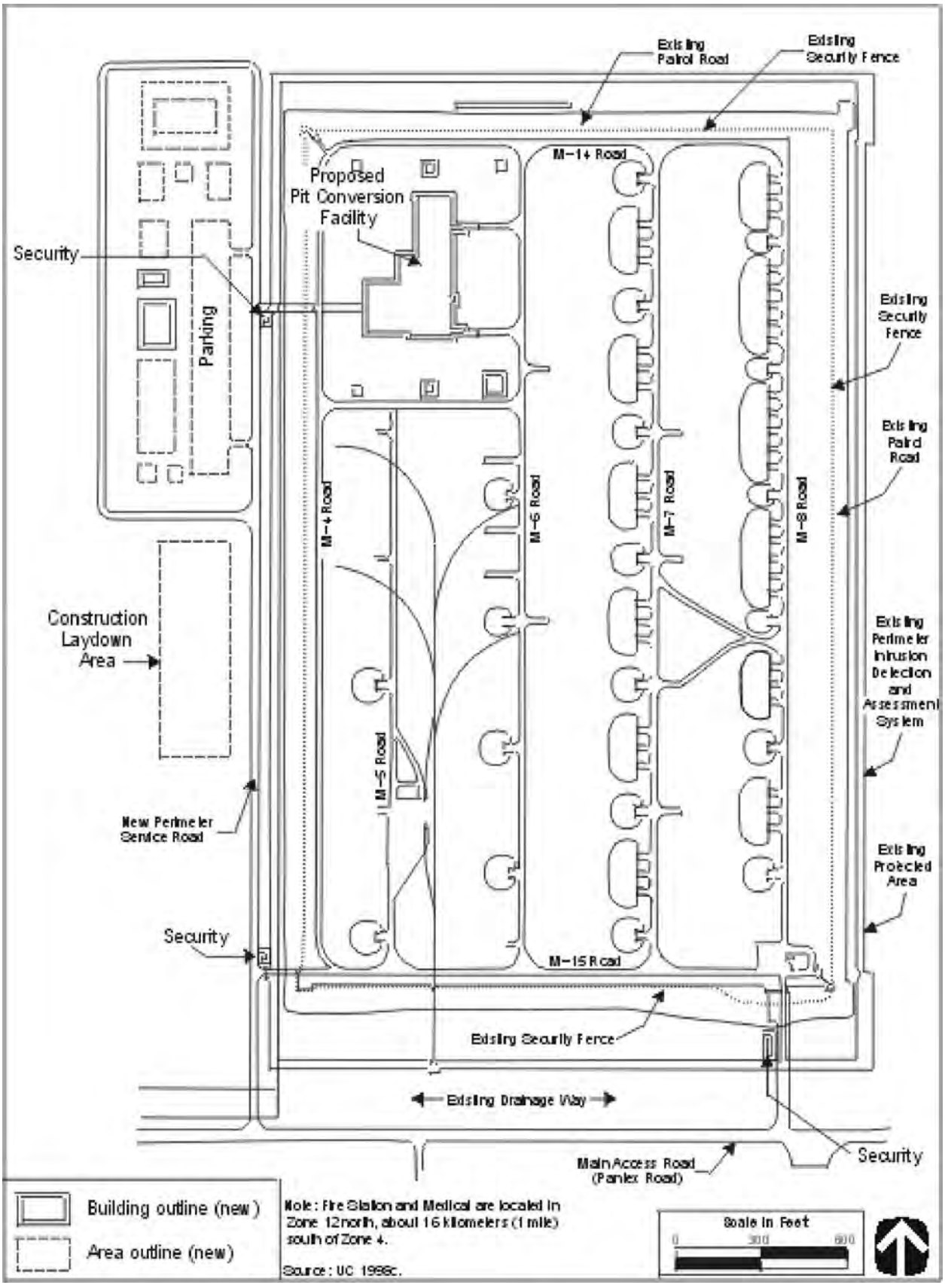


Figure 2–24. Proposed Pit Conversion Facility Location in Zone 4 West at Pantex

or in ancillary facilities. Construction would commence in about 2001 and continue through about 2003. Operations would commence in about 2004 and continue until about 2014.

Facilities at Hanford would be in the 400 Area, the immobilization facility in the FMEF and the MOX facility in new construction near FMEF. Immobilization would be concentrated on the +42- and +70-ft levels of FMEF, although process support functions would be conducted on all six floors of the building. The total space required for the immobilization facility would be about 20,000 m^2 (215,000 ft^2); the remainder of FMEF would be available for other missions.

For the MOX facility, a new two-story building of about 20,000 m^2 (215,000 ft^2) would be constructed west of FMEF. This facility would be independent of FMEF and inside its own fenced security area. In addition to the main process building, the MOX facility would require 2,300 m^2 (25,000 ft^2) of new support buildings throughout the 400 Area. The proposed disposition facilities would use such existing Hanford services as sitewide security (although there would be additional security assigned to each of the disposition facilities), emergency services, environmental monitoring, and waste management.

Modification and new construction at Hanford would commence in about 2002 and continue through about 2006. The immobilization facility would commence operations in about 2005; the MOX facility, in about 2006. The MOX facility would operate until about 2019; the immobilization facility until 2016. Operation of the MOX facility would not begin until the pit conversion facility had been operating for at least a year, so that feed material would be available for MOX fuel fabrication.

2.8.2 Alternative 4B

Pantex: Pit Conversion in New Construction
Hanford: Plutonium Conversion and Immobilization in FMEF and HLW Vitrification Facility; and MOX Fuel Fabrication in FMEF

This alternative would involve locating the pit conversion facility in new construction at Pantex and the immobilization and MOX facilities in FMEF at Hanford. Canister filling would be accomplished at the planned HLW vitrification facility scheduled for construction in the 200 East Area, about 24 km (15 mi) northwest of the 400 Area. At Pantex, the pit conversion facility would be the same as the one described for Alternative 4A in Section 2.8.1. This alternative differs from Alternative 4A in that the MOX facility would be located in FMEF rather than in new construction.

At Hanford, FMEF would be modified to contain both the MOX and immobilization facilities. While these facilities would share the building, they would be totally separate from each other to accommodate NRC regulation of the MOX facility. The immobilization facility would occupy about 14,000 m^2 (150,000 ft^2), primarily on the ground and +21-ft levels. Only the receiving area would be shared by the two facilities, but the area would be modified to physically separate the two sides and provide independent access to the two facilities.

The immobilization facility would also require the construction of a two-story annex northwest of FMEF. This building would provide approximately 6,700 m^2 (72,000 ft^2) of space for canister-loading activities and most analytical laboratory operations. The security fence surrounding FMEF would be extended to include this additional area. Material movement between FMEF and the annex would occur either by surface vehicle or through an underground tunnel between the two facilities within the protected security zone.

To implement the MOX mission at FMEF, the building would be remodeled and annexes added to accommodate the functions and processes required for MOX fuel fabrication. The MOX facility would occupy about 8,200 m^2 (88,000 ft^2) on the ground, +42-ft, and +70-ft levels of FMEF. New annex areas on the north and east sides of

the building for utilities and an entrance area with office space would add another 1,900 m^2 (20,000 ft^2) to the FMEF structure. Partition walls and other isolation mechanisms would be used to completely segregate the MOX portion of the building from the other portions. In addition to the main process building, the MOX facility would require 4,200 m^2 (45,000 ft^2) of new support buildings throughout 400 Area. The proposed disposition facilities would use such existing Hanford services as sitewide security (although there would be additional security assigned to each of the disposition facilities), emergency services, environmental monitoring, and waste management.

Modification of FMEF would commence in about 2002 and continue through about 2006. The immobilization facility would commence operations in about 2005; the MOX facility, in about 2006. The MOX facility would operate until about 2019; the immobilization facility until 2016. Operation of the MOX facility would not begin until the pit facility had been operating for at least a year, so that feed material would be available for MOX fuel fabrication.

2.9 ALTERNATIVE 5: PIT CONVERSION AT PANTEX; MOX FUEL FABRICATION AND IMMOBILIZATION AT SRS

Pantex: Pit Conversion in New Construction
SRS: MOX Fuel Fabrication in New Construction; and Immobilization in New Construction and DWPF

2.9.1 [Section heading deleted.]

This alternative would involve locating the pit conversion facility at Pantex and the immobilization and MOX facilities in new construction near the area currently designated for APSF at SRS. In addition, the canister receipt area at DWPF in S-Area would be modified as described in Section 2.4.2.1 to accommodate receipt and processing of the canisters transferred from the immobilization facility for filling with vitrified HLW. At Pantex, the pit conversion facility would be the same as the one described for Alternative 4A in Section 2.8.1.

As shown in Figure 2–22, the immobilization facility would be east of the area currently designated for APSF, and the MOX facility south of the immobilization facility. (The pit conversion facility, shown on this map, would not be located at SRS.) To accommodate both the immobilization and MOX facilities, it would be necessary to move the F-Area fence line to incorporate more area. These facilities would be constructed as described for Alternative 3 in Section 2.7.

Construction at SRS would commence in about 2002 and continue through about 2006. The immobilization facility would commence operations in about 2005; the MOX facility, in about 2006. The MOX facility would operate until about 2019; the immobilization facility until 2016. Operation of the MOX facility would not begin until the pit facility had been operating for at least a year, so that feed material would be available for MOX fuel fabrication.

2.9.2 [Section deleted because alternative deleted.]

2.10 ALTERNATIVE 6: PIT CONVERSION AND MOX FUEL FABRICATION AT HANFORD; IMMOBILIZATION AT SRS

2.10.1 Alternative 6A

Hanford: Pit Conversion in FMEF; MOX Fuel Fabrication in New Construction
SRS: Immobilization in New Construction and DWPF

This alternative would involve locating the pit conversion and MOX facilities at Hanford, in FMEF and new construction, respectively; and the immobilization facility in new construction near the area currently designated for APSF at SRS. In addition, the canister receipt area at DWPF in S-Area would be modified as described in Section 2.4.2.1 to accommodate receipt and processing of the canisters transferred from the immobilization facility for filling with vitrified HLW. In this alternative, the pit conversion facility would occupy about 13,000 m^2 (140,000 ft^2) of space on the −35-ft, −17-ft, ground, and +21-ft levels of FMEF, as described in Section 2.6; the remainder of FMEF would be available for other missions. A new two-story building would be constructed for the MOX facility, as described in Section 2.6. The proposed disposition facilities would use such existing Hanford services as sitewide security (although there would be additional security assigned to each of the disposition facilities), emergency services, environmental monitoring, and waste management.

Construction would commence in about 2001, with modifications to FMEF for the pit conversion facility, and would continue through completion of the MOX facility in about 2006. The pit conversion facility would commence operations in about 2004; the MOX facility, in about 2006. Operations would continue until about 2019, when the MOX facility has completed its mission. Operation of the MOX facility would not begin until the pit conversion facility had been operating for at least a year, so that feed material would be available for MOX fuel fabrication.

The new immobilization facility at SRS would be east of the area currently designated for APSF, as described in Section 2.7. The total space required for that facility would be about 25,000 m^2 (269,000 ft^2). Of that, 23,000 m^2 (248,000 ft^2) would be in new facilities; the remainder would be space in existing facilities that would not require further modification. To accommodate the immobilization facility, it would be necessary to move the F-Area fence line out to incorporate more area. The immobilization facility would use such existing SRS services as sitewide security (although there would be an additional security assigned to the facility), emergency services, environmental monitoring, and waste management. Construction would commence in about 2002 and continue through about 2005. Operations would commence in about 2005 and continue until about 2016.

2.10.2 Alternative 6B

Hanford: Pit Conversion and MOX Fuel Fabrication Collocated in FMEF
SRS: Immobilization in New Construction and DWPF

This alternative would involve locating both the pit conversion and MOX facilities in FMEF at Hanford, and the immobilization facility in new construction near the area currently designated for APSF at SRS. In addition, the canister receipt area at DWPF in S-Area would be modified as described in Section 2.4.2.1 to accommodate receipt and processing of the canisters transferred from the immobilization facility for filling with vitrified HLW. In this alternative, the immobilization facility would be constructed and operated at SRS as described for Alternative 6A in Section 2.10.1.

FMEF would be modified to contain both the pit conversion and MOX facilities. While these facilities would share the building, they would be totally separate from each other to accommodate NRC regulation of the MOX facility. The pit conversion facility would occupy about 13,000 m^2 (140,000 ft^2) of space on the −35-ft, −17-ft,

ground, and +21-ft levels of FMEF, as described in Section 2.6. Plutonium dioxide would be moved from the pit conversion facility to the MOX facility in a secure elevator.

To implement the MOX mission at FMEF, the building would be remodeled and annexes added to accommodate all the functions and processes required for MOX fuel fabrication. The MOX facility would occupy about 8,200 m^2 (88,000 ft^2) on the ground, +42-ft, and +70-ft levels of FMEF. The new annex areas on the north and east sides of the building for utilities and an entrance area with office space would add another 1,900 m^2 (20,000 ft^2) to the FMEF structure. Partition walls and other isolation mechanisms would be used to completely segregate the MOX portion of the building from the other portions. In addition to the main process building, the MOX facility would require 4,200 m^2 (45,000 ft^2) of new support buildings throughout 400 Area. The proposed disposition facilities would use such existing Hanford services as sitewide security (although there would be additional security assigned to each of the disposition facilities), emergency services, environmental monitoring, and waste management.

Modification of FMEF would commence in about 2001 and would continue through about 2006. The pit conversion facility would commence operations in about 2004; the MOX facility, in about 2006. Operations would cease when the MOX facility has shut down in about 2019. Operation of the MOX facility would not begin until the pit facility had been operating for at least a year, so that feed material would be available for MOX fuel fabrication.

2.10.3 [Section deleted because alternative deleted.]

2.10.4 [Section deleted because alternative deleted.]

2.11 ALTERNATIVE 7: PIT CONVERSION AND MOX FUEL FABRICATION AT INEEL; IMMOBILIZATION AT SRS

INEEL: Pit Conversion in the Fuel Processing Facility; MOX Fuel Fabrication in New Construction
SRS: Immobilization in New Construction and DWPF

2.11.1 [Section heading deleted.]

This alternative would involve locating the pit conversion facility in the Fuel Processing Facility (FPF) and the MOX facility in new construction in the Idaho Nuclear Technology and Energy Center (INTEC) area at INEEL, and the immobilization facility in new construction near the area currently designated for APSF at SRS. In addition, the canister receipt area at DWPF in S-Area would be modified as described in Section 2.4.2.1 to accommodate receipt and processing of the canisters transferred from the immobilization facility for filling with vitrified HLW. The immobilization facility would be implemented at SRS as described for Alternative 6A in Section 2.10.1.

FPF has six levels, three below grade. It is structurally complete, but has never been used. Construction was started in 1986, but discontinued in 1993, leaving essentially a concrete shell with temporary lighting and ventilation. As the building was designed to handle highly radioactive materials, it includes a number of interior thick-walled cells surrounded by corridors and access ways. Building utility areas and office space surround the corridors of the above-grade stories. Modification to the interior spaces would be required to accommodate surplus plutonium disposition activities. No radioactive materials have been introduced into the building, so the modification would neither generate radioactive waste nor contribute a radiological dose to the construction workforce. In this alternative, the pit conversion facility would occupy about 14,000 m^2 (150,000 ft^2) on four levels of FPF. No new support buildings would have to be built, as the facility's needs would be met by existing facilities at INTEC.

A new two-story building of about 20,000 m^2 (215,000 ft^2) would be constructed for the MOX facility. As shown in Figure 2–25, this building would be south of FPF. A secure underground tunnel would connect the two buildings for special nuclear material transfers. This tunnel would be locked and alarmed under normal operating conditions, and subject to the same security measures on both sides as the building perimeters, both to ensure protection of the special nuclear materials and to maintain the independence of the MOX facility. The tunnel would be opened in accordance with safeguards and security procedures for the transfer of plutonium dioxide from the pit conversion facility to the MOX facility, and would be closed immediately upon completion of transfer activities. Other than being joined to it by this tunnel, the MOX facility would be independent of FPF, and would be inside its own fenced security area. In addition to the main process building, the MOX facility would require 2,300 m^2 (25,000 ft^2) of new support buildings throughout the INTEC Area. The proposed disposition facilities would use such existing INEEL services as sitewide security (although there would be additional security assigned to each of the disposition facilities), emergency services, environmental monitoring, and waste management.

Construction would commence in about 2001, with modifications to FPF for the pit conversion facility, and would continue through completion of the MOX facility in about 2006. Operations would commence in about 2004, with pit conversion, and would continue until about 2019, when the MOX facility has completed its mission. Operation of the MOX facility would not begin until the pit conversion facility had been operating for at least a year, so that feed material would be available for MOX fuel fabrication.

2.11.2 [Section deleted because alternative deleted.]

2.12 ALTERNATIVE 8: PIT CONVERSION AND MOX FUEL FABRICATION AT INEEL; IMMOBILIZATION AT HANFORD

INEEL: Pit Conversion in FPF; MOX Fuel Fabrication in New Construction
Hanford: Immobilization in FMEF and HLW Vitrification Facility

This alternative would involve locating the pit conversion facility in FPF and the MOX facility in new construction in the INTEC area at INEEL; and the immobilization facility in FMEF at Hanford. The pit conversion and MOX facilities would be implemented at INEEL as described for Alternative 7 in Section 2.11.

At Hanford, FMEF would be modified to house the immobilization facility as described for Alternative 4A in Section 2.8.1. Canister filling would be accomplished at the planned HLW vitrification facility scheduled for construction in the 200 East Area, about 24 km (15 mi) northwest of the 400 Area. Modification of FMEF would commence in about 2002 and continue through about 2004. Operation of the immobilization facility would commence in about 2005 and continue until about 2016.

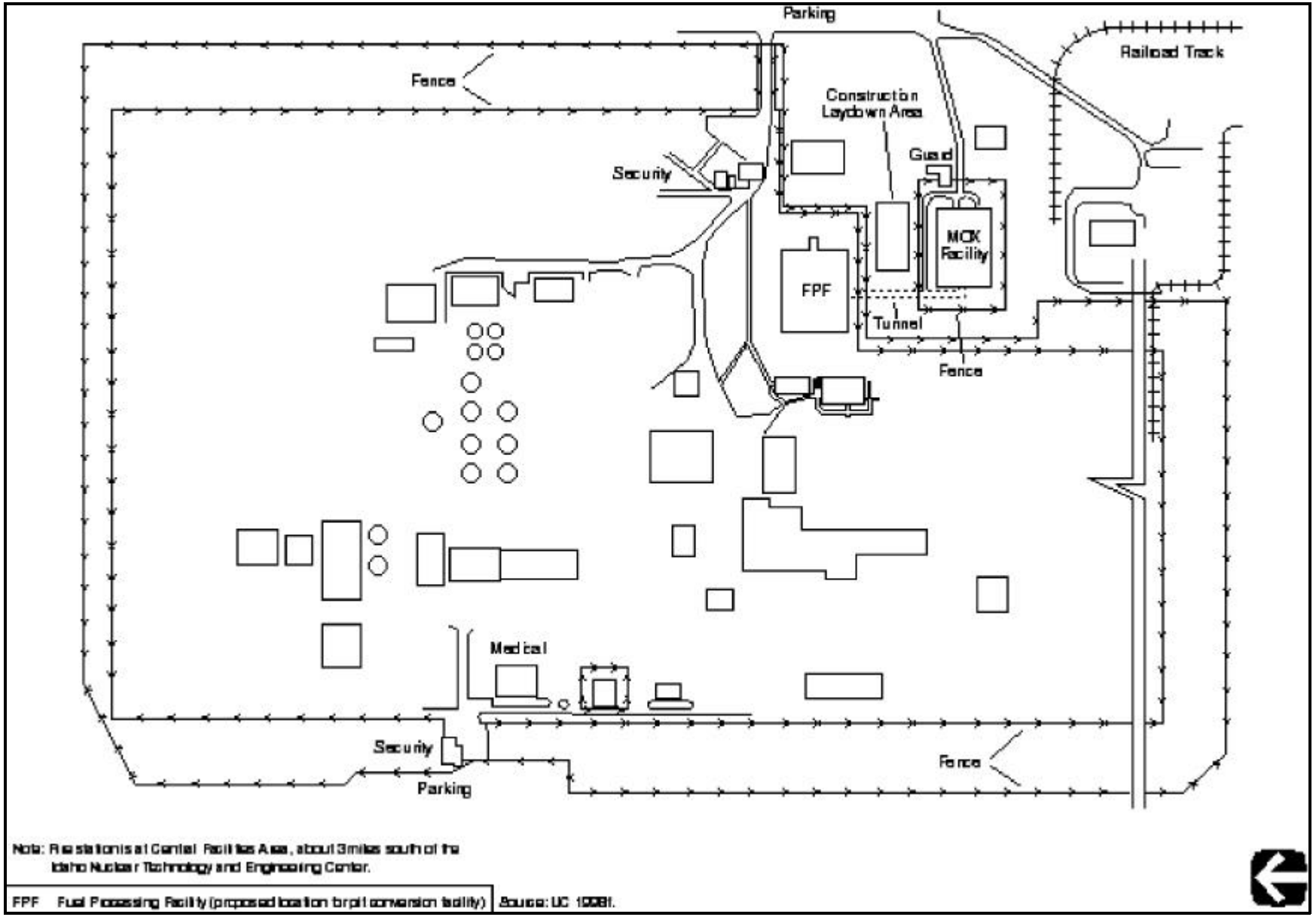


Figure 2–25. Proposed Pit Conversion and MOX Facility Locations in INTEC at INEEL

2.13 ALTERNATIVE 9: PIT CONVERSION AND MOX FUEL FABRICATION AT PANTEX; IMMOBILIZATION AT SRS

Pantex: Pit Conversion and MOX Fuel Fabrication in New Construction
SRS: Immobilization in New Construction and DWPF

2.13.1 [Section heading deleted.]

This alternative would involve locating both the pit conversion and the MOX facilities at Pantex, and the immobilization facility in new construction near the area currently designated for APSF at SRS. In addition, the canister receipt area at DWPF in S-Area would be modified as described in Section 2.4.2.1 to accommodate receipt and processing of the canisters transferred from the immobilization facility for filling with vitrified HLW. The immobilization facility would be as described in Section 2.10.1.

At Pantex, the pit conversion and MOX facilities would be in new construction in Zone 4 West (see Figure 2–26). The pit conversion facility in this alternative would be the same as that described in Section 2.8.1. For the MOX facility, a new two-story building of about 20,000 m^2 (215,000 ft^2) would be constructed south of the pit conversion facility. A secure underground tunnel would connect the two buildings for special nuclear material transfers.[21] This tunnel would be locked and alarmed under normal operating conditions, and subject to the same security measures on both sides as the building perimeters, both to ensure protection of the special nuclear materials and to maintain the independence of the MOX facility. The tunnel would be opened in accordance with safeguards and security procedures for the transfer of plutonium oxide from the pit conversion facility to the MOX facility, and would be closed immediately upon completion of transfer activities. Other than being joined by this tunnel, the MOX facility would be independent of the pit conversion facility, and would be inside its own fenced security area. In addition to the main process building, the MOX facility would require 2,300 m^2 (25,000 ft^2) of new support buildings throughout Zone 4 West. TRU waste storage would be provided in the main pit conversion and MOX facilities or in ancillary facilities. The proposed disposition facilities would use such existing Pantex services as sitewide security (although there would be additional security assigned to each of the disposition facilities), emergency services, environmental monitoring, and waste management.

Construction at Pantex would commence in about 2001 with the pit conversion facility, and continue through completion of the MOX facility in about 2006. Operations would commence in about 2004 with pit conversion, and continue until about 2019, when the MOX facility has completed its mission. Operation of the MOX facility would not begin until the pit conversion facility had been operating for at least a year, so that feed material would be available for MOX fuel fabrication.

2.13.2 [Section deleted because alternative deleted.]

[21] Current facility design includes a tunnel for material transfers. Intrasite transfers of special nuclear materials in accordance with current site practices may be considered in lieu of a tunnel in the facility design.

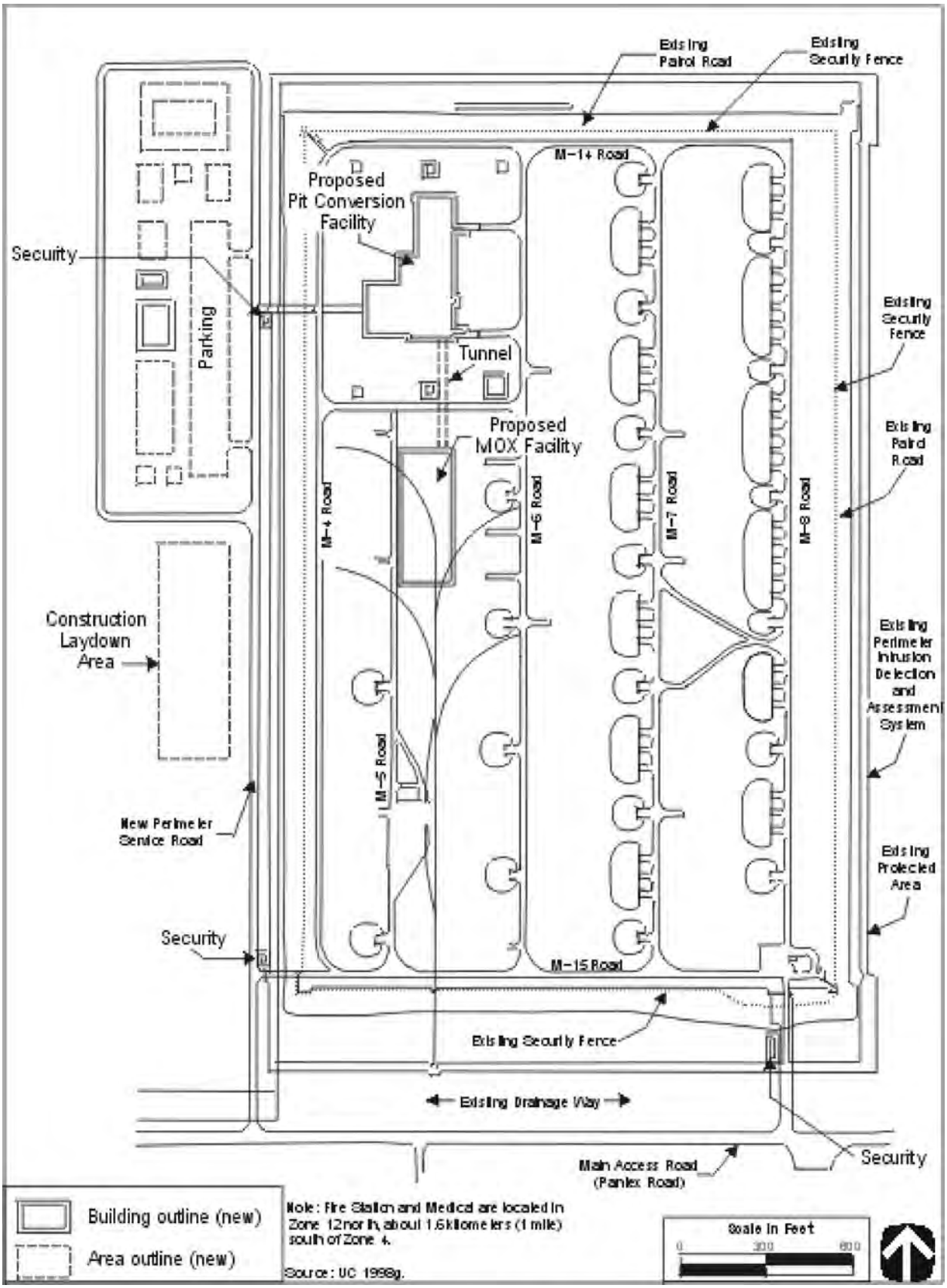


Figure 2–26. Proposed Pit Conversion and MOX Facility Locations in Zone 4 West at Pantex

2.14 ALTERNATIVE 10: PIT CONVERSION AND MOX FUEL FABRICATION AT PANTEX; IMMOBILIZATION AT HANFORD

Pantex: Pit Conversion and MOX Fuel Fabrication in New Construction
Hanford: Immobilization in FMEF and HLW Vitrification Facility

This alternative would involve locating both the pit conversion and MOX facilities in new construction at Pantex, as described for Alternative 9 in Section 2.13. The immobilization facility would be in FMEF at Hanford, and canister filling would be accomplished at the planned HLW vitrification facility scheduled for construction in the 200 East Area, about 24 km (15 mi) northwest of the 400 Area. Immobilization would be implemented as described for Alternative 8 in Section 2.12.

2.15 ALTERNATIVE 11: 50-METRIC-TON IMMOBILIZATION; IMMOBILIZATION AT HANFORD; PIT CONVERSION AT HANFORD OR PANTEX

2.15.1 Alternative 11A

Hanford: Pit Conversion in FMEF; Immobilization in FMEF and the HLW Vitrification Facility

This alternative would involve immobilizing all the nominal 50 t (55 tons) of surplus plutonium at Hanford. Therefore, only two facilities, the pit conversion and the immobilization facilities, would be needed to accomplish the surplus plutonium disposition mission. The pit conversion facility would be collocated with the immobilization facility in FMEF, as described for Alternative 2 in Section 2.6. However, all the plutonium dioxide produced in the pit conversion facility would be transferred to the immobilization facility, which would be operated at a higher throughput (5 t [5.5 tons] rather than 1.7 t [1.9 tons]) to accommodate the additional approximately 33 t (36 tons) of plutonium that would be received from the pit conversion facility. Also, the operating workforce at the immobilization facility would be increased as discussed in Section 4.20.2.3 to process the additional amount of material. Construction would commence around 2001 with the pit conversion facility, and would continue through completion of the modifications to the FMEF for the immobilization facility about 2005. Operations would commence in about 2004 with the pit conversion facility, and continue until about 2016, when the immobilization facility has completed its mission.

2.15.2 Alternative 11B

Pantex: Pit Conversion in New Construction
Hanford: Immobilization in FMEF and the HLW Vitrification Facility

This alternative would involve immobilizing all the nominal 50 t (55 tons) of surplus plutonium. Therefore, only two facilities, the pit conversion facility and the immobilization facility, would be needed to accomplish the surplus plutonium disposition mission. The pit conversion facility would be located at Pantex as described in Alternative 4A, Section 2.8.1, and the immobilization facility would be located at Hanford as described for Alternative 11A, in Section 2.15.1. All the plutonium dioxide produced in the pit conversion facility would be shipped to the immobilization facility, which would be operated as described in Section 2.15.1.

Construction would commence in about 2001 with the pit conversion facility at Pantex, and would continue through completion of the modifications to the FMEF at Hanford for the immobilization facility in about 2005. Operations would commence in about 2004 with the pit conversion facility, and continue until about 2016, when the immobilization facility has completed its mission.

2.16 ALTERNATIVE 12: 50-METRIC-TON IMMOBILIZATION; IMMOBILIZATION AT SRS; PIT CONVERSION AT PANTEX OR SRS

2.16.1 Alternative 12A

SRS: Pit Conversion in New Construction; Immobilization in New Construction and DWPF

This alternative would involve immobilizing all 50 t (55 tons) of surplus plutonium at SRS. Therefore, only two facilities, the pit conversion facility and the immobilization facility, would be needed to accomplish the surplus plutonium disposition mission. Both the pit conversion and immobilization facilities would be in new construction near the area currently designated for APSF in F-Area, as described in Section 2.7. In addition, the canister receipt area at DWPF in S-Area would be modified to accommodate receipt and processing of the canisters transferred from the immobilization facility for filling with vitrified HLW. The pit conversion and immobilization facilities would be the same as those described for Alternative 3 in Section 2.7, except that all the plutonium dioxide produced in the pit conversion facility would be transferred to the immobilization facility. To accommodate the additional 33 t (36 tons) of plutonium that would be received from the pit conversion facility, the immobilization facility would be operated at a higher throughput (5 t [5.5 tons] rather than 1.7 t [1.9 tons]), and the operating workforce at the immobilization facility would be increased as discussed in Section 4.22.2.3.

Construction would commence in about 2001 with the pit conversion facility, and continue through completion of the immobilization facility in about 2005. Operations would commence in about 2004 with the pit conversion facility, and continue until about 2016, when the immobilization facility has completed its mission.

2.16.2 [Section deleted because alternative deleted.]

2.16.3 Alternative 12B[22]

Pantex: Pit Conversion in New Construction
SRS: Immobilization in New Construction and DWPF

This alternative would involve immobilizing all the nominal 50 t (55 tons) of surplus plutonium. Therefore, only two facilities, the pit conversion facility and the immobilization facility, would be needed to accomplish the surplus plutonium disposition mission. The pit conversion facility would be located at Pantex as described in Alternative 4A, Section 2.8.1, and the immobilization facility would be located at SRS as described for Alternative 12A, in Section 2.16.1. All the plutonium dioxide produced in the pit conversion facility would be shipped to the immobilization facility, which would be operated as described in Section 2.16.1.

Construction would commence in about 2001 with the pit conversion facility at Pantex, and continue through completion of the immobilization facility at SRS in about 2005. Operations would commence in about 2004 with the pit conversion facility, and continue until about 2016, when the immobilization facility has completed its mission.

2.16.4 [Section deleted because alternative deleted.]

[22] This alternative was analyzed as Alternative 12C in the SPD Draft EIS; it has been renumbered as Alternative 12B because SPD Draft EIS Alternative 12B has been deleted.

2.17 LEAD ASSEMBLY FABRICATION AND POSTIRRADIATION EXAMINATION

Five sites are proposed for the fabrication of lead assemblies. They are LLNL, LANL, and three of the four candidate sites for the proposed surplus weapons-grade plutonium disposition activities: Hanford, INEEL (ANL–W facilities), and SRS.[23] These sites have the experience and facilities with safeguards Category I[24] and natural phenomenon hazards protection to handle the plutonium for fabricating the lead assemblies. After irradiation at McGuire, the lead assemblies may be examined at either ANL–W or ORNL. Sites considered for lead assembly activities are shown in Figure 2–1. Lead assembly fabrication and postirradiation examination would be implemented only if required to support NRC licensing activities and fuel qualification efforts. If the MOX fuel approach could be implemented without fabricating lead assemblies, or if DOE decides to immobilize all 50 t (55 tons) of surplus plutonium, then these activities would not occur. This section was developed using data provided by ORNL (O'Connor et al. 1998a–e).

2.17.1 Process Description

Lead assembly fabrication would involve the same basic process described for the full-scale fabrication of MOX fuel in Section 2.4.3.2. Although DOE plans to produce only 2 lead assemblies, as many as 10 could be produced at the lead assembly fabrication facility.[25] The fabrication effort would be implemented in existing facilities at the selected location, and the fabrication phase would be completed in about 3 years. Up to 4 fuel assemblies would be produced in any given year, for a maximum of 10 assemblies at the end of the 3-year fabrication phase. At this rate of production, about 100 kg (220 lb) plutonium would be made into MOX fuel each year. Including hot startup, a total of about 321 kg (708 lb) plutonium would be used. The plutonium would come from pits dismantled during the Pit Disassembly and Conversion Demonstration Project or from existing supplies of surplus metal and oxide at LANL. Two extra MOX fuel rods would be fabricated with each lead assembly to be maintained as unirradiated archives. The archived rods would be stored at the lead assembly facility until the completion of all the lead assembly fabrication, irradiation, and testing. The rods would then be shipped to the MOX facility for storage until it was determined that the rods were no longer needed as archived material for fuel qualification purposes. At that time, the archived rods would either be irradiated, or dismantled and the materials reused in the MOX fabrication process.

At the lead assembly fabrication site, plutonium dioxide would be blended with uranium dioxide originating from depleted uranium hexafluoride in DOE storage at, for example, the Portsmouth Gaseous Diffusion Plant, then formed into pellets, sintered, and loaded into rods. After fabrication, the rods would either be assembled into fuel assemblies and transported to the reactor, or transported as rods to the reactor site for insertion into special assemblies prior to irradiation. The lead assemblies would be inserted into the reactor during a refueling outage and left in the reactor for up to three fuel cycles. After removal from the reactor, the irradiated assemblies would be managed at the reactor site as spent fuel while cooling down for approximately 6 months. After the cooldown period, several fuel rods removed from the lead assemblies at the reactor site would be transported to ANL–W or ORNL for postirradiation examination. The rest of the rods would remain in the spent fuel pool and would be managed as spent nuclear fuel.

---

[23] Pantex was not considered for lead assembly fabrication because it does not currently have any facilities capable of MOX fuel fabrication.

[24] DOE protects nuclear materials based on the relative attractiveness of the materials in constructing a weapon and/or improvised nuclear device. Category I facilities provide the highest level of safeguards and security.

[25] As discussed in Sections 2.18.2 and 4.27, should fewer lead assemblies than analyzed be fabricated or irradiated, the potential impacts would be lower than those described.

During postirradiation examination, several of the fuel rods would be subjected to a series of nondestructive and destructive tests to evaluate the physical and chemical changes to the fuel material and cladding resulting from irradiation. Activities would be conducted remotely, with the irradiated fuel rods inside a hot cell. Operators would remain outside the hot cell and would be shielded by the walls and windows of that cell. Any postirradiation examination activities and shipments would comply with the Consent Order and Settlement Agreement in Public Service Company of Colorado vs. Batt (if the work were performed at ANL–W) and all other applicable agreements and orders, including provisions concerning removal of the material from the applicable examination site and limits on the number of truck shipments to the site.

The lead assembly fabrication facility would be operational by October 2002, with the first lead assemblies available for insertion by late 2003. After lead assembly fabrication is completed, deactivation would take about 3 years and could involve conversion of the space for another mission or missions.

2.17.2 Lead Assembly Fabrication Siting Alternatives

If required, lead assembly fabrication and postirradiation examination would be conducted at operating DOE sites in facilities that can accommodate the proposed activities with minimal alteration of interior spaces, are authorized to handle plutonium, and are situated in hardened spaces of thick-walled concrete that meet the standards for processing special nuclear material. Areas of the buildings in which plutonium would be handled are designed to survive natural phenomena such as earthquakes, floods, and tornadoes, as well as potential accidents associated with the processing of fissile and radioactive materials.

Security at these facilities, implemented at several levels, would provide maximum protection for the special nuclear materials. Each facility would be on an existing DOE site that has safeguards and security measures in place, including access control. In addition to DOE sitewide security services, each building in which special nuclear materials are handled has physical security and procedures commensurate with the amount and type of material authorized in the area. Physical barriers; access control systems; detection and alarm systems; procedures, including the two-person rule (requiring at least two people to be present during work with special nuclear materials in the facility); and personnel security measures, including security clearance investigations and access authorization levels—all ensure that special nuclear materials are adequately protected. Nuclear material control and accountability are ensured through a system for monitoring storage, processing, and transfers. At any time, the total amount of special nuclear material in each facility, or in any material balance area within a facility, would be known. As appropriate, closed-circuit television, intrusion detection, motion detection, and other automated methods are used as part of the material control and accountability program. Physical measurements and inspections of material are used to verify inventory records.

2.17.2.1 Hanford

The Fuel Assembly Area of FMEF, within Hanford's 400 Area (see Figures 2–2 and 2–20) has been proposed as a location for lead assembly fabrication. FMEF, also proposed as a candidate location for the pit conversion, immobilization, and MOX facilities, is described in detail in Section 2.6.

FMEF consists of several connected buildings. Building 427, the main part of the facility, is a six-level processing building with an attached mechanical wing on the west side and an emergency power wing on the northwest corner. The Fuel Assembly Area (Building 4862) is appended to the southeastern end of FMEF. This area is divided into two sections, the entry (administrative) wing, and the lower-level operations portion, the Fuel Assembly Area, designed for the fabrication of fuel assemblies for FFTF. The lower level of the Fuel Assembly Area would be used for fuel rod and assembly fabrication. The upper level contains independent ventilation equipment. Storage of plutonium feed materials would occur in the operating vaults of Building 427, or in reconfigured below-grade storage tubes in the Fuel Assembly Area.

2.17.2.2 ANL–W

ANL–W is in the southeast portion of INEEL (see Figure 2–3). Established in the mid-1950s, the facility had as its primary mission the support of advanced liquid metal reactor research. In 1995, ANL–W began conducting research in the treatment of DOE spent nuclear fuel and in technologies for reactor decontamination and decommissioning. The ZPPR Vault and Workroom (Building 775), ZPPR Reactor Cell (Building 776), Fuel Manufacturing Facility (FMF, Building 704), and Fuel Assembly and Storage Building, (FASB, Building 787) within ANL–W have been proposed to support lead assembly fabrication (see Figure 2–27). As discussed in Sections 2.17.3 and 2.17.3.1, postirradiation examination could also be conducted at ANL–W.

ZPPR began operations at ANL–W in 1969 and was placed on standby in 1989. The facility is large enough to enable core physics studies of full-scale breeder reactors. The principal experimental area has a very thick foundation and thick concrete walls covered with an earthen mound, and a sand/gravel/HEPA filter roof. FMF, adjacent to the ZPPR facility, is buried under an earthen mound similar to that of ZPPR. This facility is currently supporting a furnace and glovebox operation for the dismantlement of damaged ZPPR fuel plates and the packaging of recovered plutonium oxide for shipment. FMF is also used as a test site for the development of safeguards and security systems. ZPPR and FMF share security assets, including a common security area surrounded by security fences, perimeter intrusion detection, and alarm systems. ZPPR and FMF are both Safeguards Category I, hardened buildings which meet natural phenomenon protection requirements currently approved for handling special nuclear materials.

The ZPPR Workroom has been proposed for fuel manufacture and storage, and the ZPPR Reactor Cell, as the high-bay fuel assembly and inspection area. Space within FMF would be used for fuel storage. The FASB would also be used for lead assembly fabrication. This facility was constructed to provide space, equipment, and services for manufacturing fuel elements and components for an experimental breeder reactor. A metallurgical laboratory is housed in the building's west end. The FASB would provide controlled vault storage for special nuclear materials, including fuel assemblies.

2.17.2.3 SRS

SRS is in the southern portion of South Carolina, approximately 19 km (12 mi) south of Aiken (see Figure 2–5). Chemical processing facilities are situated within the F- and H-Canyon areas at SRS. Their primary mission was to separate special nuclear materials from spent reactor fuels and irradiated targets. A portion of the 221–H Canyon facility, located within the H-Area, has been proposed for the fabrication of lead assemblies (see Figure 2–28). This unused space originally constructed for the Uranium Solidification Facility (USF), was never completed. The 221–H facility is entirely within a protected safeguards and security area. Existing USF utilities, access control, administrative and laboratory space, and waste management systems would also be used for the proposed lead assembly fabrication activities.

2.17.2.4 LANL

LANL, in northern New Mexico, was established in 1943 to design, develop, and test nuclear weapons (see Figure 2–29). Its mission has expanded from the primary task of designing nuclear weapons to include nonnuclear defense programs and a broad array of nondefense programs. Current programs include research and development of nuclear safeguards and security, medium-energy physics, space nuclear systems, biomedicine, computational science, and lasers. As discussed in Section 2.17.1, the plutonium dioxide feed material for the lead assembly fabrication effort is expected to be produced at LANL.

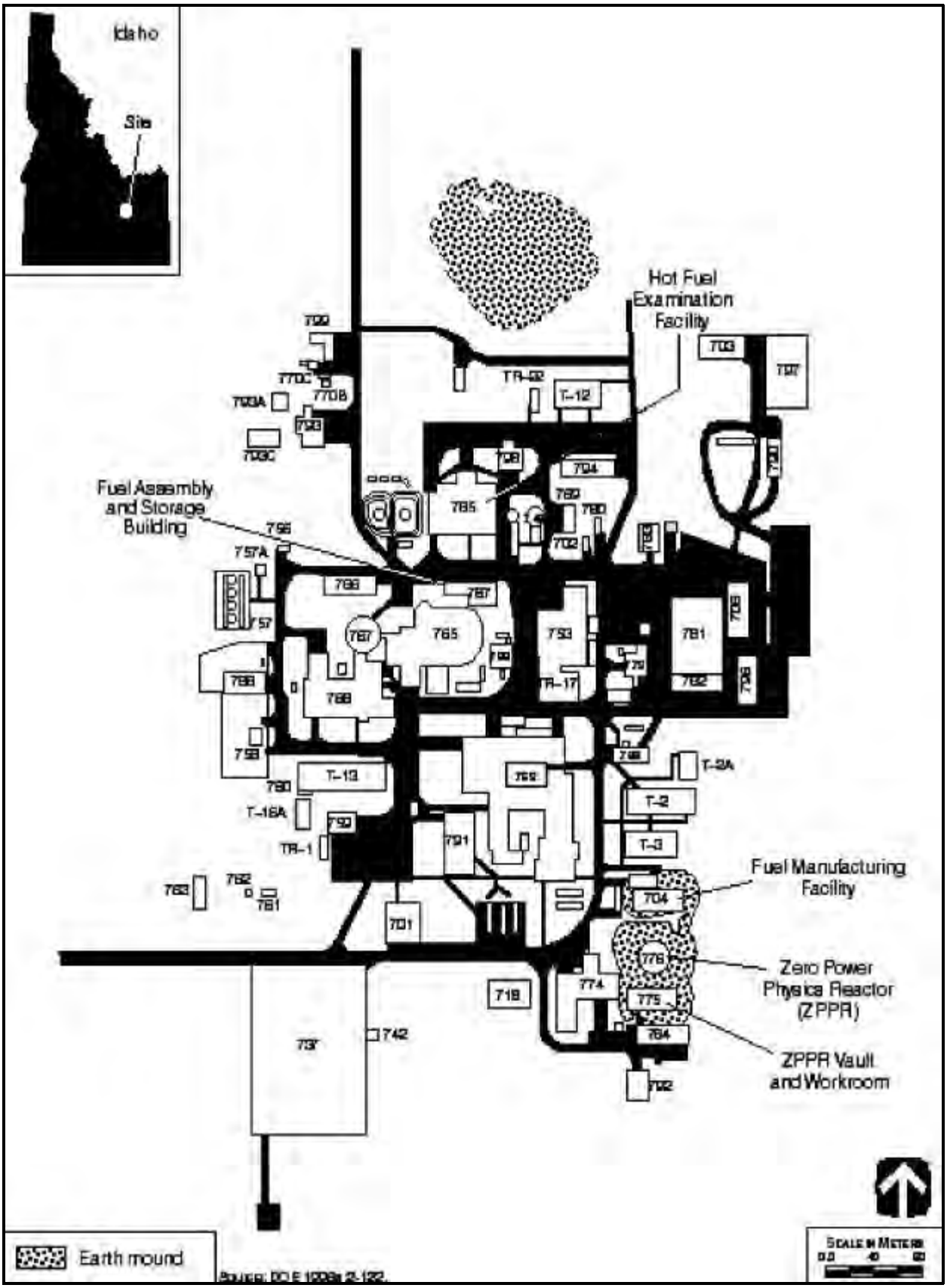


Figure 2–27. Proposed MOX Fuel Lead Assembly Fabrication Facilities, ANL–W at INEEL

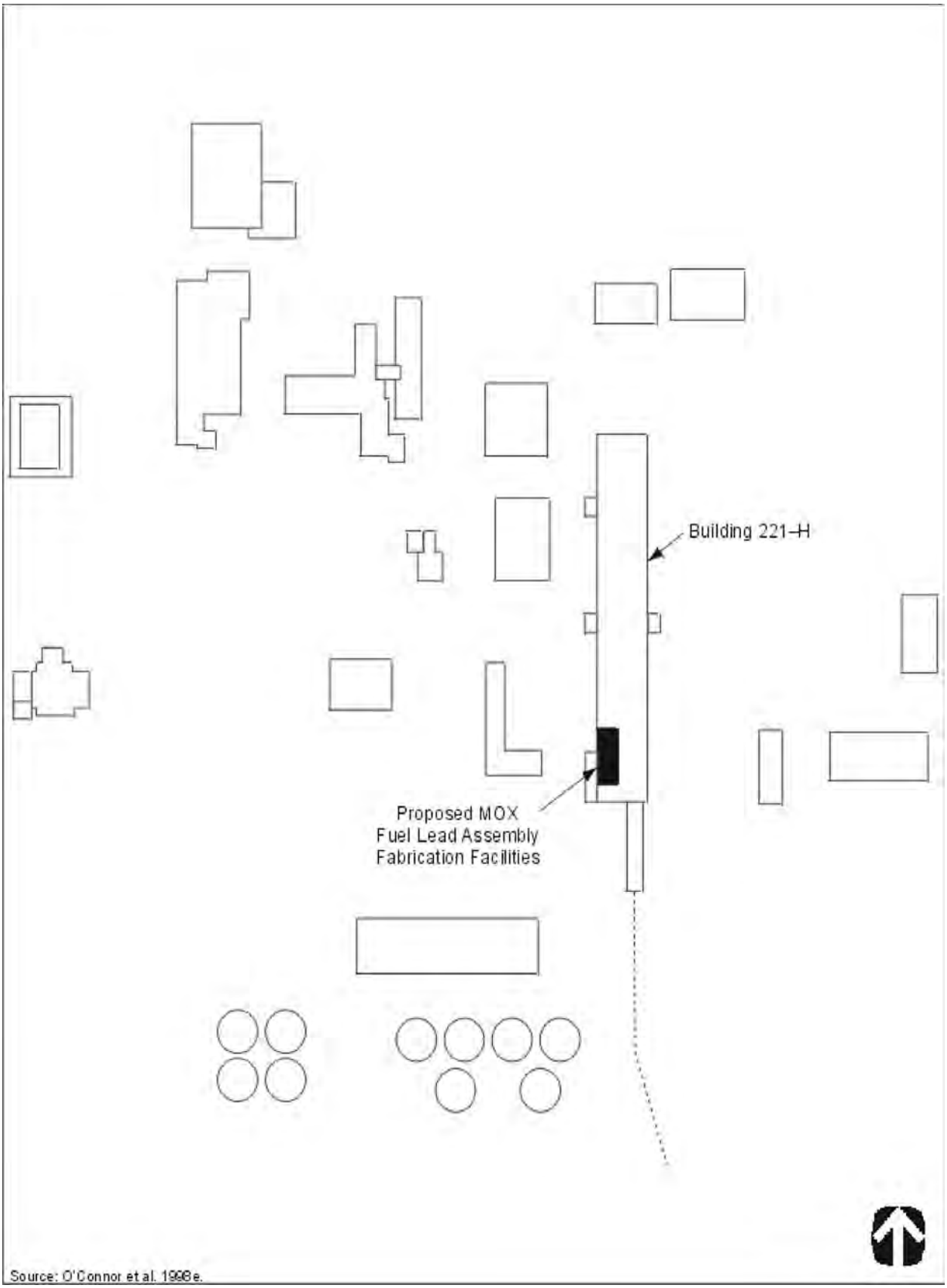


Figure 2–28. Proposed MOX Fuel Lead Assembly Fabrication Facilities, H-Area at SRS

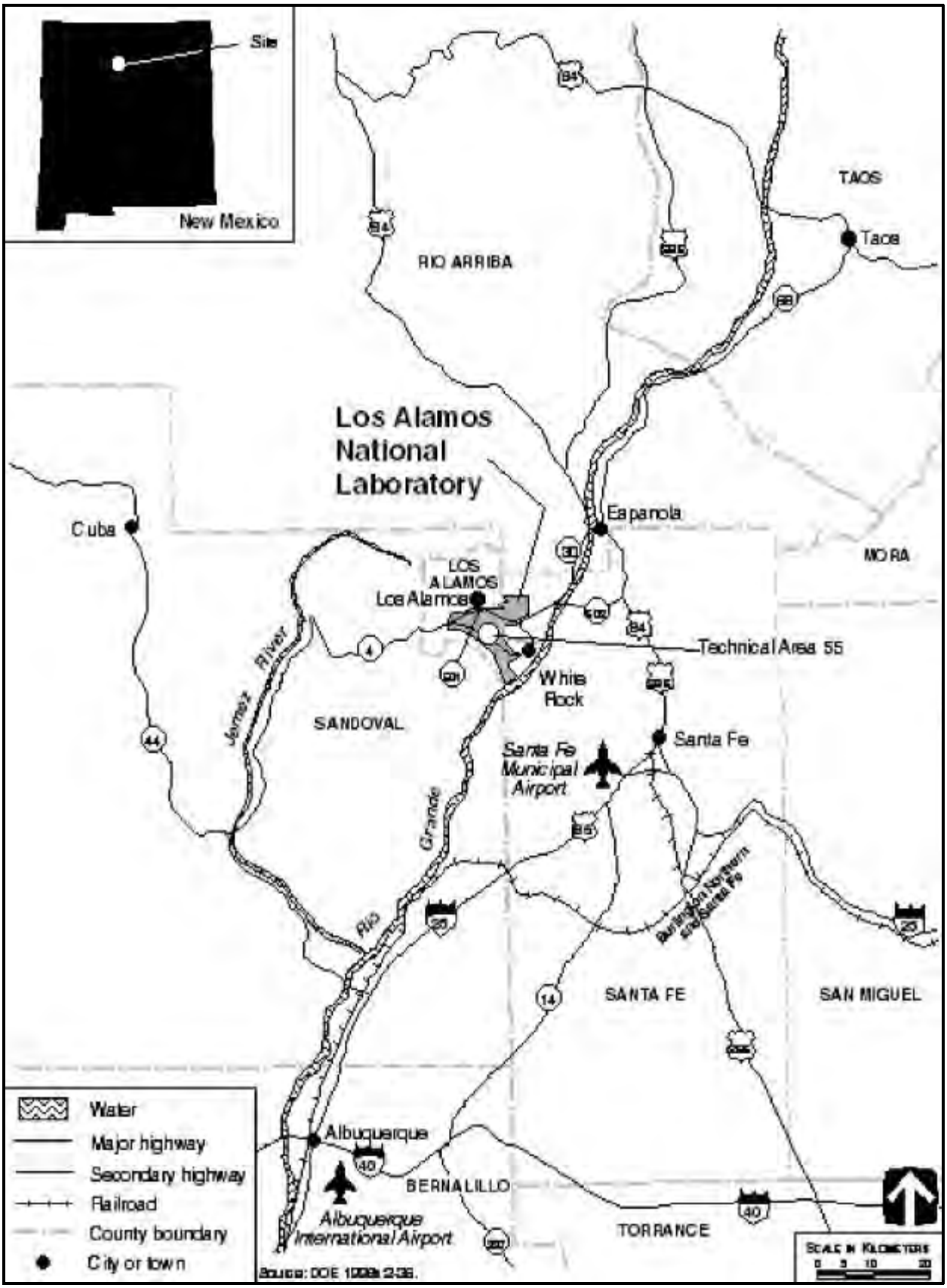


Figure 2–29. LANL, New Mexico

LANL consists primarily of Technical Areas, of which 49 are actively in use. With the exception of the bundle assembly and inspection activities proposed for the Radioactive Materials Research, Operations and Demonstration Facility in TA–50, the facilities proposed for lead assembly fabrication and storage of archived fuel rods are in Building PF–4 within TA–55 (see Figure 2–30). Most of TA–55, including the main complex, is inside a restricted area surrounded by a double security fence. In addition to Building PF–4, the TA–55 main complex consists of the Administration Building (PF–1), Support Office Building (PF–2), Support Building (PF–3), Warehouse (PF–5), and other miscellaneous support buildings.

Fuel fabrication activities have been proposed for currently operational fuel fabrication laboratories in Building PF–4, which became operational in 1978 for conducting state-of-the-art plutonium processing. Current activities in the building include plutonium recovery, fabrication of plutonium components, weapons disassembly, plutonium 238 and actinide processing, and fabrication of ceramic-based reactor fuels.

2.17.2.5 LLNL

The main LLNL site, originally a naval air training station, is approximately 80 km (50 mi) east of San Francisco and 6.4 km (4 mi) from downtown Livermore (see Figure 2–31). LLNL was established in 1952 to conduct nuclear weapons research. Its current mission is research, testing, and development focusing on national defense and security, energy, the environment, and biomedicine. Within recent years, LLNL's mission has broadened to include global security, ecology, and mathematics and science education.

Buildings 332, 334, and 335 are the three primary facilities proposed to support fabrication of lead assemblies. The Plutonium Facility (Building 332) is inside LLNL's Superblock, a 500-ft by 700-ft protected area surrounded by an alarmed double security fence (see Figure 2–32). Building 332 comprises several buildings constructed over the past three decades, including the Plenum Building, an office structure, plutonium-handling laboratories, mechanical shops, office space, a small nonradioactive materials laboratory, two plutonium storage vaults, and a cold machine shop. Current activities in the Plutonium Facility include the receipt, storage, and shipping of special nuclear materials; plutonium and fissile uranium operations and experiments; special nuclear material control and accountability; scrap recovery; and waste operations. For the lead assembly fabrication effort, Building 332 would be used to receive and store bulk plutonium dioxide powder, fabricate MOX pellets, and assemble fuel rods.

Building 334, adjacent to Building 332 in the Superblock, can handle maximum quantities of encapsulated special nuclear materials. This three-floor facility comprises the Engineering Test Bay (ETB) and the Radiation Measurements Facility (RMF). The ETB is used to conduct thermal and dynamic tests on weapon components; the RMF, located in the Intrinsic Radiation (INRAD) bay, to make intrinsic radiation measurements of various components. The INRAD and ETB bays provide primary and secondary confinement of radioactive material. For the proposed lead assembly fabrication, the ETB would be used for assembling, storing, packaging, and shipping fuel assemblies. Building 334 also contains analytical, metallography, scrap recovery, and other equipment to support the proposed activities.

Building 335, also adjacent to Building 332, is used as a staging area for nonradioactive equipment and systems being readied to move into Building 332. There are also areas for training, document storage, and change rooms, as well as access into the radioactive materials area of Building 332. For the lead assembly fabrication effort, Building 335 would be used for assembly and testing of equipment, storage of spare parts and supplies, and electrical and mechanical shop areas. The proposed activities can be accomplished within LLNL's administrative limits for uranium and plutonium inventory as identified in the *Supplement Analysis for Continued Operation of Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore* (DOE 1999c).

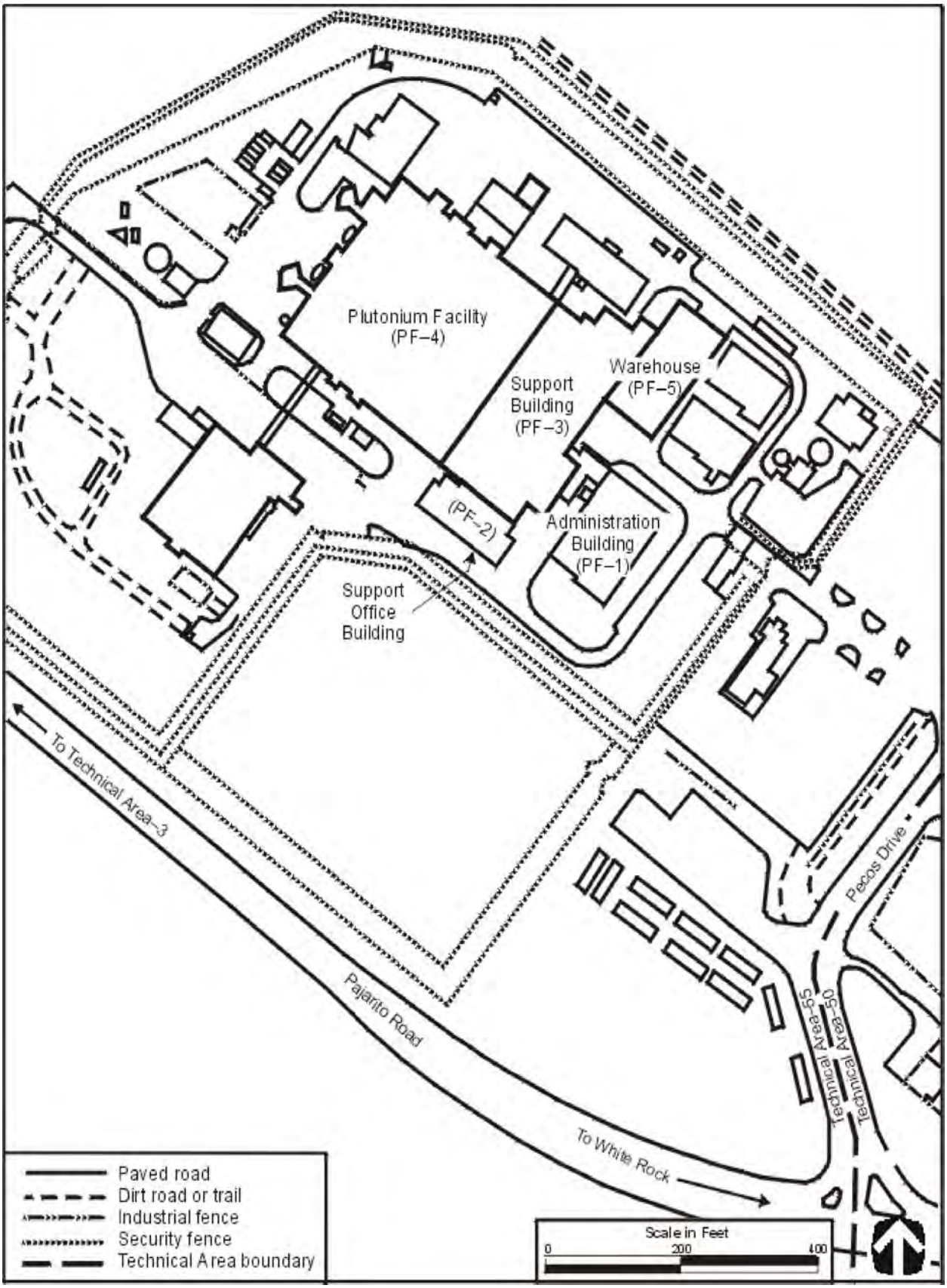


Figure 2–30. Proposed MOX Fuel Lead Assembly Fabrication Facilities, TA–55 at LANL

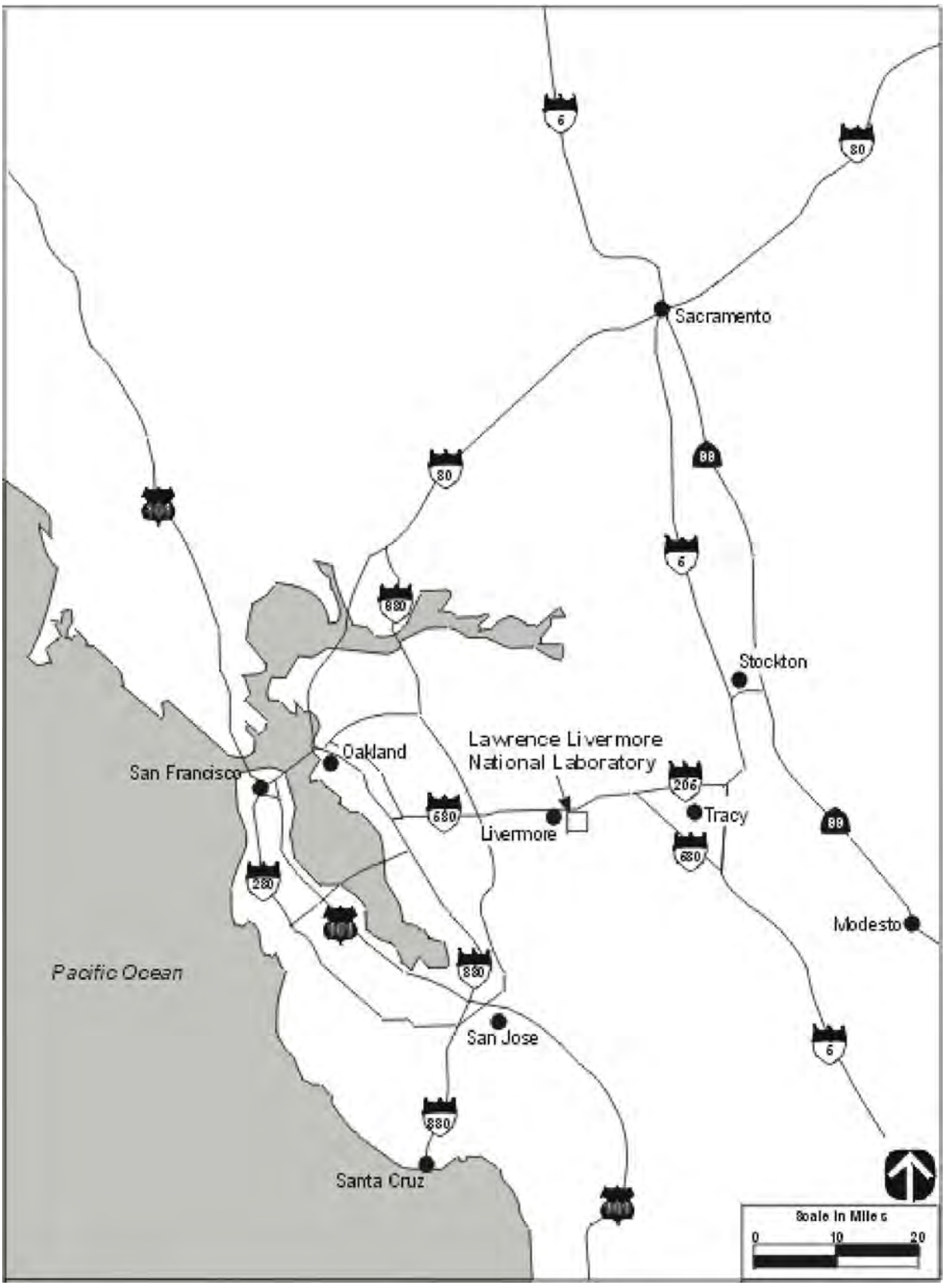


Figure 2–31. LLNL, California

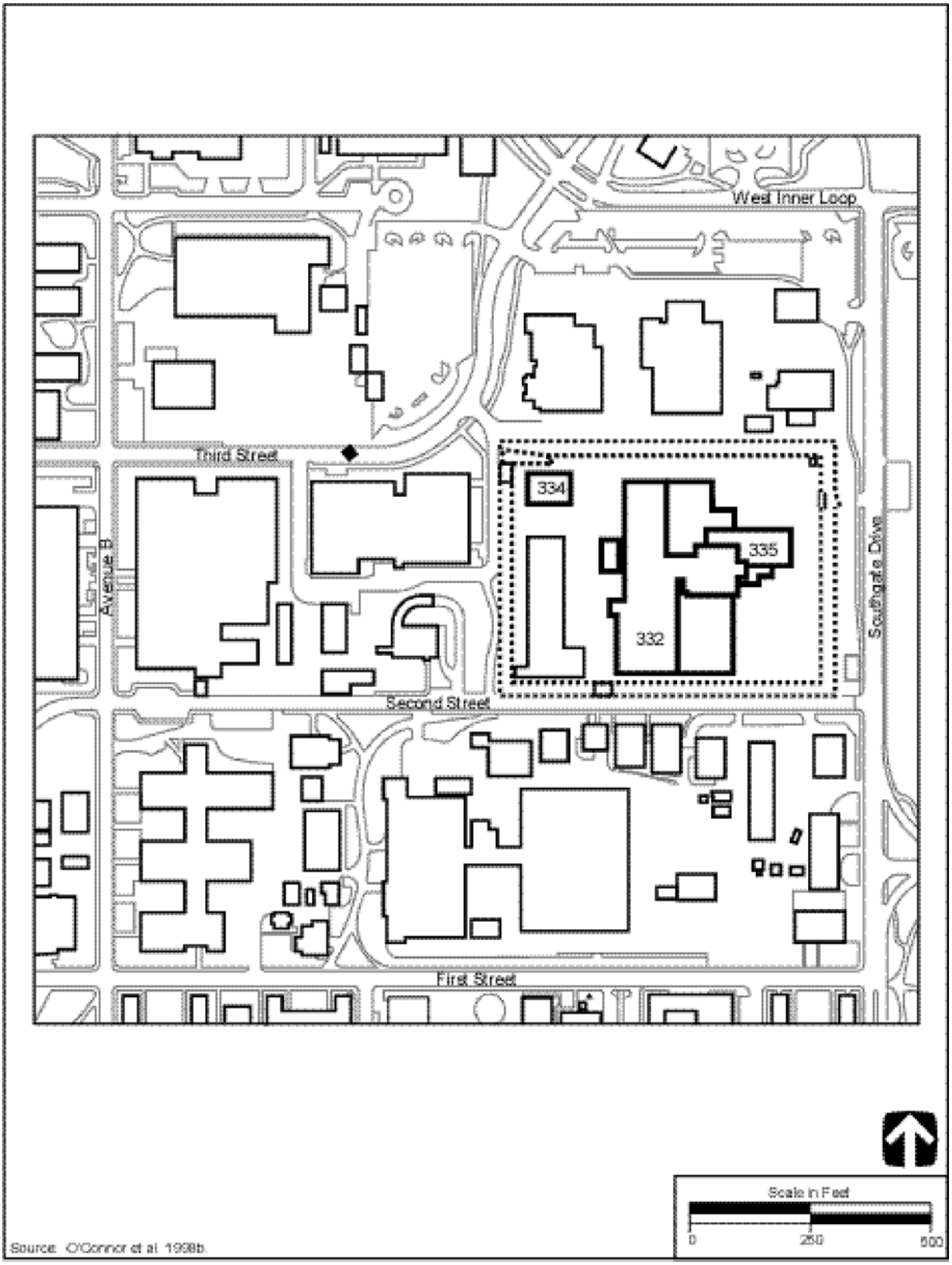


Figure 2–32. Proposed MOX Fuel Lead Assembly Fabrication Facilities, Superblock at LLNL

2.17.3 Postirradiation Examination Siting Alternatives

Postirradiation examination is used to collect information about fuel assemblies after irradiation. Tests on the lead assemblies would begin with remote nondestructive examination, which typically involves a visual examination of the fuel rods to detect signs of damage or wear, as well as the measurement of physical parameters such as length, diameter, and weight. The nondestructive tests would continue with more rigorous tests such as ultrasonic tests, x- or gamma spectroscopy, and neutron radiography. After completion of the nondestructive testing, which does not compromise the integrity of the material being examined, the rods would be subjected to destructive testing: they would be punctured to collect contained gases, then cut into segments for metallurgical and ceramographic testing, chemical analysis, electron microscopy, and other physical testing. Such tests, standard industry and research activities, would provide information on how the fuel material and the cladding responded to being inside the operating reactor. DOE proposes to conduct any required postirradiation examination at either ANL–W or ORNL because these facilities have hot cells (special facilities which are heavily shielded and have remote-handling equipment for working with highly radioactive materials) and testing equipment that are routinely required for these activities. Both sites currently process materials equivalent to those that would be handled during postirradiation examination of these lead assemblies. At either site, only minimal modifications to existing equipment would be required for acceptance of commercial-sized, full-length fuel rods.

Waste generated by destructive testing of the lead assemblies would be managed at the postirradiation examination site as TRU waste. Irradiated fuel rods sent to the postirradiation examination facility that are not destroyed in testing would be managed at the postirradiation examination site as spent fuel, in accordance with the site's spent fuel program. This spent fuel from the lead assembly program may be stored at the postirradiation examination site until transported to INEEL, where it would remain in storage pending disposition at a potential geologic repository pursuant to the NWPA.[26]

2.17.3.1 ANL–W

The Hot Fuel Examination Facility (HFEF) is a hot cell complex for the preparation and examination of irradiated experiments and the characterization and testing of waste forms from conditioning of spent fuel and waste. HFEF is located in a double-fenced compound on the ANL–W site at INEEL (see Figure 2–27). HFEF consists of two adjacent shielded hot cells, a shielded metallographic loading box, an unshielded Hot Repair Area and a Waste Characterization Area. The building is a three-story structure with a basement support area, and has a gross floor area of about 5,200 m^2 (56,000 ft^2).

The HFEF main cell is 21 m (70 ft) long by 9 m (30 ft) wide by 7.5 m (25 ft) high, and has an argon gas atmosphere. The cell is serviced by two electro-mechanical manipulators rated for 340 kg (750 lb) and two 5-ton bridge cranes. There are 15 workstations, each equipped with two master/slave manipulators.

The primary program at HFEF, since October 1994, has been the support of the Experimental Breeder Reactor II (EBR–II) defueling and decommissioning. HFEF was responsible for receiving all the fuel and blanket material from EBR–II and preparing the material for storage in the Radioactive Scrap and Waste Facility.

In addition to the handling of the EBR–II fuel, HFEF is the examination facility for both the metal and ceramic waste form experiments from the Fuel Conditioning Facility. In addition, equipment is being installed and

[26] Transportation and storage at INEEL would be in accordance with decisions made in the ROD for the *Department of Energy Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Environmental Impact Statement*.

processes tested for the disposal of the plutonium and fission product waste from the conditioning of EBR–II fuel. The testing and characterization of the ceramic waste forms will be performed in HFEF.

HFEF is presently being modified to accept commercial-sized fuel assemblies. All the examination equipment in the cell and the cask handling systems are being modified to handle commercial sized casks and fuel rods for examination. These modification are expected to be complete in mid-1999.

2.17.3.2 ORNL

The Irradiated Fuels Examination Laboratory (IFEL), Building 3525, has been used for fuel research and examination. It is part of ORNL approximately 14 km (8 mi) southwest of the city of Oak Ridge, Tennessee. Over a period of three decades, this facility has handled a wide variety of fuels including aluminum clad research reactor fuel, both stainless and zircaloy clad LWR fuel, coated-particle gas cooled reactor fuel, and numerous one of a kind fuel test specimens. In addition, the facility has also done iridium isotope processing and irradiated capsule disassembly.

The IFEL contains a large horseshoe-shaped array of hot cells which are divided into three work areas. The hot cells are constructed of 3-ft thick concrete walls with oil-filled lead glass viewing windows. The inside of surfaces of the cell bank are lined with stainless steel to provide containment of particulate matter and to facilitate decontamination. Special penetrations are provided for the sealed entry of services such as instrument lines, lights, and electrical power. A pair of manipulators are located at each of 15 window stations for remote cell operations and periscopes allow for magnified views of in-cell objects. Heavy objects within each cell bank can be moved by electromechanical manipulators or a 3-ton crane. Fuel materials enter and leave the cells through three shielded transfer stations provided at the rear face of the North cell.

2.18 SUMMARY OF IMPACTS OF CONSTRUCTION AND OPERATION OF THE PROPOSED SURPLUS PLUTONIUM DISPOSITION FACILITIES

This section summarizes the potential impacts associated with the activities necessary to implement DOE's disposition strategy for surplus plutonium. The summary addresses the environmental information to be considered for each of the decisions contemplated as part of this strategy. This information is compiled from the analyses presented in Chapter 4 of this SPD EIS. Section 2.18.1 summarizes impacts related to the proposed surplus plutonium disposition facilities and provides that information by alternative, and within each alternative, by site. Summarized impacts are presented for the No Action Alternative as well as for each of the 15 alternatives that encompass the range of reasonable alternatives for both the 50-t (55-ton) immobilization and the hybrid approaches to plutonium disposition. Section 2.18.2 compares the potential impacts related to implementation of lead assembly fabrication at five candidate sites and postirradiation examination at two candidate sites. To provide an overview of the impacts associated with full implementation of the MOX fuel approach to disposition, Section 2.18.3 presents an integrated assessment of the potential impacts of the MOX facility, lead assembly fabrication, postirradiation examination, and use of the MOX fuel in domestic, commercial reactors. To facilitate the evaluation of proposed immobilization technologies, the final section compares the impacts associated with the can-in-canister immobilization technology with those described in the *Storage and Disposition PEIS* for the ceramic immobilization and vitrification alternatives.

2.18.1 Summary of Impacts by Alternative and Site

Table 2–4 summarizes the potential impacts of the No Action and surplus plutonium disposition facility alternatives on key environmental resource areas. In addition, the amount of land that would be disturbed and the potential impacts from facility accidents and transportation are summarized. Impacts are presented by

alternative, and within each alternative, by the affected site. For the No Action Alternative, sites that currently store surplus plutonium are included in the table.

Impacts on air quality are expected to be low for all alternatives. Table 2–4 provides the incremental criteria pollutant concentrations from surplus plutonium disposition operations for each alternative. In all cases, the incremental concentrations would contribute less than 2 percent of the applicable regulatory standard. Total site air concentrations, which also factor in the amount associated with the No Action Alternative,[27] would be no more than 21 percent of the annual applicable regulatory standard, with the highest occurring in the alternatives that would have the immobilization facility located at SRS. That particular value represents projected sulfur dioxide concentrations as a percent of the annual National Ambient Air Quality Standards; the corresponding value for the No Action Alternative is also 21 percent, demonstrating that the increment associated with plutonium disposition facilities would be very small.[28]

Expected waste generation by alternative is estimated for TRU waste, LLW, mixed LLW, hazardous waste, and nonhazardous waste[29] from construction activities and 10 years of expected facility operation. As shown in Chapter 4, impacts associated with management of nonhazardous wastes would be minor and would not tend to be a discriminator among alternatives.

TRU waste generation would range from 1,400 m^3 (1,832 yd^3) to 1,810 m^3 (2,368 yd^3), and LLW generation would range from 1,700 m^3 (2,224 yd^3) to 2,400 m^3 (3,140 yd^3). Mixed waste generation would range from 20 m^3 (26 yd^3) for immobilizing all 50 t (55 tons) (Alternatives 11A, 11B, 12A, and 12B) to 50 m^3 (65 yd^3) for each of the hybrid alternatives. Hazardous waste generation would range from 770 m^3 (1,007 yd^3) (Alternatives 11A and 11B) to 940 m^3 (1,230 yd^3) (Alternatives 3, 5, 6A, 6B, 7, and 9).

Impacts on the waste management infrastructure from implementing alternatives for surplus plutonium disposition are expected to be minor. All of the waste expected to be generated from the different alternatives analyzed could be accommodated within existing or planned capacities for waste treatment, storage, and disposal at all of the candidate sites, except for TRU waste at Pantex. At Pantex, a maximum of 860 m^3 (1,125 yd^3) of TRU waste would be generated under Alternative 9 or 10. Because TRU waste is not routinely generated and stored at Pantex, TRU waste storage space would be designated within the pit conversion and MOX facilities. TRU waste would be shipped to WIPP near Carlsbad, New Mexico, for disposal.

Although the proposed facilities are still in the early stages of engineering and design, the surplus plutonium disposition program would integrate pollution prevention practices that include waste stream minimization, source reduction, and recycling, as well as DOE procurement processes that preferentially procure products made from recycled materials. The proposed facility designs would minimize the size of radiologically controlled areas, thereby minimizing the generation of radioactive waste. To the extent practical, solvents or other chemicals which, after use, are regulated by the Resource Conservation and Recovery Act would not be used at the DOE facilities, thereby minimizing the amount of hazardous and mixed waste generated. Wastewater would be recycled to the extent possible to minimize effluent discharge.

The employment column of Table 2–4 summarizes the number of direct jobs that would be generated by the proposed facilities under each alternative. All the action alternatives would generate employment opportunities

[27] As indicated in Appendix G, the No Action Alternative projects air emissions to the year 2005, when plutonium disposition facility operations under the disposition alternatives would begin, and includes emissions from existing and other planned facilities.

[28] This conclusion assumes that activity levels under the No Action Alternative remain the same beyond 2005.

[29] Waste type definitions may be found in Appendix F.8.

at the facilities. Expected annual peak construction employment ranges from 463 workers (Alternative 11A) to 2,143 workers (Alternative 5).[30] Annual employment during operations would range from 751 workers (Alternatives 12A and 12B) to 1,165 workers (Alternatives 2 and 4B).

Potential effects on human health from facility construction, 10 years of operation, postulated facility accidents and intersite transportation of radioactive materials are also summarized in Table 2–4. Doses to workers from the construction and 10 years of routine operation of the three surplus plutonium disposition facilities at DOE sites would result in up to 2.0 latent cancer fatalities (LCFs) for both the hybrid alternatives and the 50-t (55-ton) immobilization alternatives. No LCFs would be expected to occur in the general population during routine operations. Under the No Action Alternative, continued storage of the surplus plutonium would also not result in any LCFs to the general population during routine operations. Doses to workers from the long-term storage (up to 50 years) of the surplus plutonium would result in up to 2.4 LCFs.

Table 2–4 presents the results of the analysis of the most severe nonreactor design basis accident scenario. For Alternative 4B, a criticality in the MOX facility would result in the most severe consequences. For all other alternatives except the No Action Alternative, a design basis fire in the pit conversion facility resulting in a tritium release would result in the most severe consequences. However, no design basis accident would be expected to result in LCFs in the general population.

No major consequences for the maximally exposed involved worker would be expected from leaks, spills, and smaller fires. These accidents are such that involved workers would either be able to evacuate immediately or would not be affected by the events. Explosions, on the other hand, could result in immediate injuries from flying debris, as well as the uptake of plutonium and uranium particulates through inhalation. If a criticality were to occur, workers within tens of meters could receive very high to fatal radiation exposures from the initial burst. The dose would strongly depend on the magnitude of the criticality (number of fissions), the distance from the criticality, and the amount of shielding provided by the structures and equipment between the workers and the criticality. Beyond-design-basis earthquakes would also have substantial consequences, ranging from workers being killed by debris from collapsing equipment and structures to high radiation exposures and uptakes of radionuclides. For most accidents, immediate emergency response actions should reduce the consequences to workers near the accident.

Materials transportation is analyzed to determine potential radiological and nonradiological impacts from routine and accident conditions. These results are summarized in Table 2–4. Transportation includes the movement of surplus plutonium from storage and among the proposed disposition facilities; depleted uranium hexafluoride from, for example, Portsmouth to a conversion facility; uranium dioxide from the conversion facility to the immobilization and/or MOX facilities; recovered HEU from the pit conversion facility to ORR; MOX fuel to Catawba, McGuire, and North Anna; spent nuclear fuel resulting from lead assembly irradiation at McGuire to the postirradiation examination site and then to storage at INEEL; and the immobilized plutonium to a potential geologic repository.[31] No traffic fatalities from nonradiological accidents or LCFs from radiological exposures or vehicle emissions would be expected. For the hybrid alternatives, the number of trips would range from 1,917 (Alternative 10) to 2,530 (Alternatives 3, 6A, 6B, and 7), and the cumulative distances traveled would range from 3.6 million km (2.2 million mi) (Alternative 10) to 8.7 million km (5.4 million mi) (Alternatives 6A and 6B).

[30] These values represent the combined peak annual construction workforce at each site. Peak construction employment under Alternative 11A is composed of the 463 construction workers at Hanford in 2003. Peak construction employment under Alternative 5 is composed of the 451 construction workers at Pantex in 2002 and the 1,692 construction workers at SRS in 2003.

[31] Shipments of spent fuel to the potential geologic repository are analyzed in the *Draft Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada* (DOE/EIS-0250D) (DOE 1999b).

Immobilization-only alternatives would require from 1,877 trips for Alternative 11B to 2,236 trips for Alternative 12A. Cumulative distances traveled for the immobilization-only alternatives would range from 2.5 million km (1.5 million mi) (Alternative 11B) to 4.4 million km (2.7 million mi) (Alternative 12A).

Table 2–4 also provides the total land area that would be disturbed at each site for each alternative. Land disturbance relates directly to impacts on ecological resources, cultural resources, geology and soils, and land use and visual resources. The amount of land that would be disturbed for the hybrid alternatives would range from 19 hectares (47 acres) in Alternative 8, to 32 hectares (79 acres) in Alternatives 3, 5, and 9. Because these land areas are in or adjacent to previously disturbed areas and represent a very small percent of the land available at the candidate sites, the impacts on geology and soils and land use would be minor. Land disturbance associated with immobilizing approximately 50 t (55 tons) of surplus plutonium would range from 9.5 hectares (23 acres) in Alternative 11B, to 20 hectares (49 acres) in Alternative 12A or 12B. Construction and operation of the proposed facilities would not effect a significant change in any natural features of visual interest in the area of any of the candidate sites. No major impact is anticipated for any threatened or endangered species because there have been no sightings near the proposed facility locations at the candidate sites. Cultural resource impacts would be minor at all sites because at all sites except SRS, construction of facilities would be in mostly disturbed or developed areas; at SRS, cultural resource areas would be avoided. Archaeological investigations near F-Area have discovered five sites that could be impacted by construction of surplus plutonium disposition facilities. Two of these sites have been recommended to the South Carolina State Historic Preservation Officer (SHPO) as eligible for nomination to the National Register of Historic Places. Potential adverse impacts could be mitigated through either avoidance or data recovery. DOE currently plans to mitigate impacts by avoiding sites that are eligible or potentially eligible for nomination to the National Register. Cultural resource compliance activities would be conducted in accordance with the *Programmatic Memorandum of Agreement for the Savannah River Site* (SRARP 1989:179–188).

Impacts were also assessed on water availability and quality and infrastructure including requirements for roads, electricity, and fuel. These evaluations indicated that all impacts would be minor. [Text deleted.] None of the alternatives were found to pose a significant risk (when probability is considered) to the general population, nor would implementation of any of the alternatives result in a significant risk of disproportionately high and adverse impacts on minority or low-income groups within the general population.

Table 2–4. Summary of Impacts of Construction and Operation of Surplus Plutonium Disposition Facilities by Alternative and Site

Site	Air Quality[a] (incremental pollutant concentrations in $\mu g/m^3$)	Waste Management[b] (m^3)	Employment[c] (direct)	Land Disturbance[d] (ha)	Human Health Risk[e] (dose in person-rem)	Facility Accidents[f]	Transportation[g]
Alternative 1: No Action							
Hanford	No change	No change	No change	None	Dose Public: 4.7×10^{-2} Workers: 46 LCFs Public: 1.2×10^{-3} Workers: 0.92	NA	None
INEEL	No change	No change	No change	None	Dose Public: 7.6×10^{-5} Workers: 1.5 LCFs Public: 1.9×10^{-6} Workers: 2.9×10^{-2}	NA	None
Pantex	No change	No change	No change	None	Dose Public: 6.3×10^{-6} Storage Workers: 3 Packaging Workers: 16 LCFs Public: 1.6×10^{-7} Storage Workers: 6.0×10^{-2} Packaging Workers: 6.4×10^{-2}	NA	None

Table 2–4. Summary of Impacts of Construction and Operation of Surplus Plutonium Disposition Facilities by Alternative and Site

Site	Air Quality[a] (incremental pollutant concentrations in $\mu g/m^3$)	Waste Management[b] (m^3)	Employment[c] (direct)	Land Disturbance[d] (ha)	Human Health Risk[e] (dose in person-rem)	Facility Accidents[f]	Transportation[g]
SRS	No change	No change	No change	None	Dose Public: 2.9×10^{-4} Workers: 7.5 LCFs Public: 7.2×10^{-6} Workers: 0.15	NA	None
LLNL	No change	No change	No change	None	Dose Public: 6.7×10^{-3} Workers: 25 LCFs Public: 1.7×10^{-4} Workers: 0.50	NA	None
LANL	No change	No change	No change	None	Dose Public: 2.7 Workers: 12.5 LCFs Public: 6.8×10^{-2} Workers: 0.25	NA	None
RFETS	No change	No change	No change	None	Dose Public: 0.10 Workers: 25 LCFs Public: 2.5×10^{-3} Workers: 0.50	NA	None

Table 2–4. Summary of Impacts of Construction and Operation of Surplus Plutonium Disposition Facilities by Alternative and Site

Site	Air Quality[a] (incremental pollutant concentrations in $\mu g/m^3$)	Waste Management[b] (m^3)	Employment[c] (direct)	Land Disturbance[d] (ha)	Human Health Risk[e] (dose in person-rem)	Facility Accidents[f]	Transportation[g]
SRS	No change	No change	No change	None	Dose Public: 2.9×10^{-4} Workers: 7.5 LCFs Public: 7.2×10^{-6} Workers: 0.15	NA	None
LLNL	No change	No change	No change	None	Dose Public: 6.7×10^{-3} Workers: 25 LCFs Public: 1.7×10^{-4} Workers: 0.50	NA	None
LANL	No change	No change	No change	None	Dose Public: 2.7 Workers: 12.5 LCFs Public: 6.8×10^{-2} Workers: 0.25	NA	None
RFETS	No change	No change	No change	None	Dose Public: 0.10 Workers: 25 LCFs Public: 2.5×10^{-3} Workers: 0.50	NA	None

Table 2–4. Summary of Impacts of Construction and Operation of Surplus Plutonium Disposition Facilities by Alternative and Site

Site	Air Quality[a] (incremental pollutant concentrations in $\mu g/m^3$)	Waste Management[b] (m^3)	Employment[c] (direct)	Land Disturbance[d] (ha)	Human Health Risk[e] (dose in person-rem)	Facility Accidents[f]	Transportation[g]
Alternative 2: Pit Conversion in FMEF, Immobilization in FMEF and HLWVF, and MOX in New Construction at Hanford							
Hanford	CO: 0.651 NO_2: 0.0873 PM_{10}: 0.00541 SO_2: 0.00496	TRU: 1,800 LLW: 2,300 MLLW: 50 Haz: 800	Construction: 1,235 Operations: 1,165	22	Construction (workforce) Dose: 0 LCFs: 0 Operations Dose Public: 7.2 Workers: 488 LCFs Public: 3.6×10^{-2} Workers: 2.0	Tritium release at pit conversion facility: 0.11 LCF	LCFs: 6.1×10^{-2} Traffic fatalities: 7.4×10^{-2} Kilometers traveled: 7.5M Additional risk of LCFs at Pantex: 8.3×10^{-2}

Table 2–4. Summary of Impacts of Construction and Operation of Surplus Plutonium Disposition Facilities by Alternative and Site

Site	Air Quality[a] (incremental pollutant concentrations in $\mu g/m^3$)	Waste Management[b] (m^3)	Employment[c] (direct)	Land Disturbance[d] (ha)	Human Health Risk[e] (dose in person-rem)	Facility Accidents[f]	Transportation[g]
Alternative 3: Pit Conversion, Immobilization, and MOX in New Construction at SRS							
SRS	CO: 0.37 NO_2: 0.0634 PM_{10}: 0.00423 SO_2: 0.124	TRU: 1,800 LLW: 2,400 MLLW: 50 Haz: 940	Construction: 1,968 Operations: 1,120	32 Disturbance could impact a site potentially eligible for the National Register of Historic Places	Construction (workforce) Dose: 4.1 LCFs: 1.6×10^{-3} Operations Dose Public: 1.8 Workers: 456 LCFs Public: 9.0×10^{-3} Workers: 1.8	Tritium release at pit conversion facility: 5.0×10^{-2} LCF	LCFs: 8.1×10^{-2} Traffic fatalities: 5.3×10^{-2} Kilometers traveled: 4.3M Additonal risk of LCFs at Pantex: 8.3×10^{-2}
[Text deleted because alternative deleted.][h]							

Table 2–4. Summary of Impacts of Construction and Operation of Surplus Plutonium Disposition Facilities by Alternative and Site

Site	Air Quality[a] (incremental pollutant concentrations in $\mu g/m^3$)	Waste Management[b] (m^3)	Employment[c] (direct)	Land Disturbance[d] (ha)	Human Health Risk[e] (dose in person-rem)	Facility Accidents[f]	Transportation[g]
Alternative 4A: Pit Conversion in New Construction at Pantex, and Immobilization in FMEF and HLWVF and MOX in New Construction at Hanford							
Pantex	CO: 0.381 NO_2: 0.0374 PM_{10}: 0.00215 SO_2: 0.00064	TRU: 180 LLW: 600 MLLW: 10 Haz: 20	Construction: 451 Operations: 400	5.0	Construction (workforce) Dose: 0 LCFs: 0 Operations Dose Public: 0.58 Workers: 192 LCFs Public: 2.9×10^{-3} Workers: 0.77	Tritium release at pit conversion facility: 1.8×10^{-2} LCF	LCFs: 5.7×10^{-2} Traffic fatalities: 6.5×10^{-2} Kilometers traveled: 6.3M Additional risk of LCFs at Pantex: 0
Hanford	CO: 0.374 NO_2: 0.052 PM_{10}: 0.00367 SO_2: 0.00343	TRU: 1,600 LLW: 1,700 MLLW: 40 Haz: 780	Construction: 1,148 Operations: 720	16	Construction (workforce) Dose: 0 LCFs: 0 Operations Dose Public: 0.30 Workers: 264 LCFs Public: 1.5×10^{-3} Workers: 1.1	Nuclear criticality at MOX facility: 1.9×10^{-2} LCF	

Table 2–4. Summary of Impacts of Construction and Operation of Surplus Plutonium Disposition Facilities by Alternative and Site

Site	Air Quality[a] (incremental pollutant concentrations in $\mu g/m^3$)	Waste Management[b] (m^3)	Employment[c] (direct)	Land Disturbance[d] (ha)	Human Health Risk[e] (dose in person-rem)	Facility Accidents[f]	Transportation[g]
Alternative 4B: Pit Conversion in New Construction at Pantex, and Immobilization in FMEF and HLWVF and MOX in FMEF at Hanford							
Pantex	CO: 0.381 NO_2: 0.0374 PM_{10}: 0.00215 SO_2: 0.00064	TRU: 180 LLW: 600 MLLW: 10 Haz: 20	Construction: 451 Operations: 400	5.0	Construction (workforce) Dose: 0 LCFs: 0 Operations Dose Public: 0.58 Workers: 192 LCFs Public: 2.9×10^{-3} Workers: 0.77	Tritium release at pit conversion facility: 1.8×10^{-2} LCF	LCFs: 5.7×10^{-2} Traffic fatalities: 6.5×10^{-2} Kilometers traveled: 6.3M Additional risk of LCFs at Pantex: 0
Hanford	CO: 0.507 NO_2: 0.0707 PM_{10}: 0.00499 SO_2: 0.00468	TRU: 1,600 LLW: 1,700 MLLW: 40 Haz: 780	Construction: 1,064 Operations: 765	17.4	Construction (workforce) Dose: 0 LCFs: 0 Operations Dose Public: 0.15 Workers: 296 LCFs Public: 7.3×10^{-4} Workers: 1.2	Nuclear criticality at MOX or immobilization facility: 1.9×10^{-2} LCF	

Table 2–4. Summary of Impacts of Construction and Operation of Surplus Plutonium Disposition Facilities by Alternative and Site

Site	Air Quality[a] (incremental pollutant concentrations in $\mu g/m^3$)	Waste Management[b] (m^3)	Employment[c] (direct)	Land Disturbance[d] (ha)	Human Health Risk[e] (dose in person-rem)	Facility Accidents[f]	Transportation[g]
Alternative 5: Pit Conversion in New Construction at Pantex, and Immobilization in New Construction and DWPF and MOX in New Construction at SRS							
Pantex	CO: 0.381 NO_2: 0.0374 PM_{10}: 0.00215 SO_2: 0.00064	TRU: 180 LLW: 600 MLLW: 10 Haz: 20	Construction: 451 Operations: 400	5.0	Construction (workforce) Dose: 0 LCFs: 0 Operations Dose Public: 0.58 Workers: 192 LCFs Public: 2.9×10^{-3} Workers: 0.77	Tritium release at pit conversion facility: 1.8×10^{-2} LCF	LCFs: 7.7×10^{-2} Traffic fatalities: 5.0×10^{-2} Kilometers traveled: 3.8M Additional risk of LCFs at Pantex: 0
SRS	CO: 0.275 NO_2: 0.0347 PM_{10}: 0.0024 SO_2: 0.0829	TRU: 1,600 LLW: 1,800 MLLW: 40 Haz: 920	Construction: 1,692 Operations: 720	27 Disturbance could impact a site potentially eligible for the National Register of Historic Places	Construction (workforce) Dose: 2.7 LCFs: 1.1×10^{-3} Operations Dose Public: 1.8×10^{-2} Workers: 264 LCFs Public: 9.2×10^{-4} Workers: 1.1	Nuclear criticality at MOX facility: 8.0×10^{-3} LCF	

Table 2–4. Summary of Impacts of Construction and Operation of Surplus Plutonium Disposition Facilities by Alternative and Site

Site	Air Quality[a] (incremental pollutant concentrations in $\mu g/m^3$)	Waste Management[b] (m^3)	Employment[c] (direct)	Land Disturbance[d] (ha)	Human Health Risk[e] (dose in person-rem)	Facility Accidents[f]	Transportation[g]
Alternative 6A: Pit Conversion in FMEF and MOX in New Construction at Hanford, and Immobilization in New Construction and DWPF at SRS							
Hanford	CO: 0.247 NO_2: 0.031 PM_{10}: 0.00143 SO_2: 0.00123	TRU: 860 LLW: 1,500 MLLW: 40 Haz: 50	Construction: 844 Operations: 785	14	Construction (workforce) Dose: 0 LCFs: 0 Operations Dose Public: 7.2 Workers: 214 LCFs Public: 3.6×10^{-2} Workers: 0.86	Tritium release at pit conversion facility: 0.11 LCF	LCFs: 9.6×10^{-2} Traffic fatalities: 9.1×10^{-2} Kilometers traveled: 8.6M Additional risk of LCFs at Pantex: 8.3×10^{-2}
SRS	CO: 0.152 NO_2: 0.0242 PM_{10}: 0.00181 SO_2: 0.0442	TRU: 950 LLW: 810 MLLW: 10 Haz: 890	Construction: 1,014 Operations: 335	15 Disturbance could impact a site potentially eligible for the National Register of Historic Places	Construction (workforce) Dose: 1.5 LCFs: 6.0×10^{-4} Operations Dose Public: 2.8×10^{-3} Workers: 242 LCFs Public: 1.4×10^{-5} Workers: 0.97	Nuclear criticality at immobilization facility: 8.0×10^{-4} LCF	

Table 2–4. Summary of Impacts of Construction and Operation of Surplus Plutonium Disposition Facilities by Alternative and Site

Site	Air Quality[a] (incremental pollutant concentrations in $\mu g/m^3$)	Waste Management[b] (m^3)	Employment[c] (direct)	Land Disturbance[d] (ha)	Human Health Risk[e] (dose in person-rem)	Facility Accidents[f]	Transportation[g]
Alternative 6B: Pit Conversion and MOX Collocated in FMEF at Hanford, and Immobilization in New Construction and DWPF at SRS							
Hanford	CO: 0.247 NO_2: 0.031 PM_{10}: 0.00143 SO_2: 0.00123	TRU: 860 LLW: 1,500 MLLW: 40 Haz: 50	Construction: 655 Operations: 785	14	Construction (workforce) Dose: 0 LCFs: 0 Operations Dose Public: 7.0 Workers: 214 LCFs Public: 3.5×10^{-2} Workers: 0.86	Tritium release at pit conversion facility: 0.11 LCF	LCFs: 9.6×10^{-2} Traffic fatalities: 9.1×10^{-2} Kilometers traveled: 8.6M Additional risk of LCFs at Pantex: 8.3×10^{-2}
SRS	CO: 0.152 NO_2: 0.0242 PM_{10}: 0.00181 SO_2: 0.0442	TRU: 950 LLW: 810 MLLW: 10 Haz: 890	Construction: 1,014 Operations: 335	15 Disturbance could impact a site potentially eligible for the National Register of Historic Places	Construction (workforce) Dose: 1.5 LCFs: 6.0×10^{-4} Operations Dose Public: 2.8×10^{-3} Workers: 242 LCFs Public: 1.4×10^{-5} Workers: 0.97	Nuclear criticality at immobilization facility: 8.0×10^{-4} LCF	

Table 2–4. Summary of Impacts of Construction and Operation of Surplus Plutonium Disposition Facilities by Alternative and Site

Site	Air Quality[a] (incremental pollutant concentrations in $\mu g/m^3$)	Waste Management[b] (m^3)	Employment[c] (direct)	Land Disturbance[d] (ha)	Human Health Risk[e] (dose in person-rem)	Facility Accidents[f]	Transportation[g]
Alternative 7: Pit Conversion in FPF and MOX in New Construction at INEEL, and Immobilization in New Construction and DWPF at SRS							
INEEL	CO: 0.762 NO_2: 0.144 PM_{10}: 0.00833 SO_2: 0.345	TRU: 860 LLW: 1,500 MLLW: 40 Haz: 50	Construction: 866 Operations: 743	14	Construction (workforce) Dose: 2.0 LCFs: 7.7×10^{-4} Operations Dose Public: 2.2 Workers: 192 LCFs Public: 1.1×10^{-2} Workers: 0.77	Tritium release at pit conversion facility: 4.4×10^{-3} LCF	LCFs: 9.4×10^{-2} Traffic fatalities: 8.3×10^{-2} Kilometers traveled: 7.5M Additional risks of LCFs at Pantex: 8.3×10^{-2}
SRS	CO: 0.152 NO_2: 0.0242 PM_{10}: 0.00181 SO_2: 0.0442	TRU: 950 LLW: 810 MLLW: 10 Haz: 890	Construction: 1,014 Operations: 335	15 Disturbance could impact a site potentially eligible for the National Register of Historic Places	Construction (workforce) Dose: 1.5 LCFs: 6.0×10^{-4} Operations Dose Public: 2.8×10^{-3} Workers: 242 LCFs Public: 1.4×10^{-5} Workers: 0.97	Nuclear criticality at immobilization facility: 8.0×10^{-4} LCF	

Table 2–4. Summary of Impacts of Construction and Operation of Surplus Plutonium Disposition Facilities by Alternative and Site

Site	Air Quality[a] (incremental pollutant concentrations in $\mu g/m^3$)	Waste Management[b] (m^3)	Employment[c] (direct)	Land Disturbance[d] (ha)	Human Health Risk[e] (dose in person-rem)	Facility Accidents[f]	Transportation[g]
Alternative 8: Pit Conversion in FPF and MOX in New Construction at INEEL, and Immobilization in FMEF and HLWVF at Hanford							
INEEL	CO: 0.762 NO_2: 0.144 PM_{10}: 0.00833 SO_2: 0.345	TRU: 860 LLW: 1,500 MLLW: 40 Haz: 50	Construction: 866 Operations: 743	14	Construction (workforce) Dose: 2.0 LCFs: 7.7×10^{-4} Operations Dose Public: 2.2 Workers: 192 LCFs Public: 1.1×10^{-2} Workers: 0.77	Tritium release at pit conversion facility: 4.4×10^{-3} LCF	LCFs: 5.9×10^{-2} Traffic fatalities: 6.5×10^{-2} Kilometers traveled: 6.3M Additional risks of LCFs at Pantex: 8.3×10^{-2}
Hanford	CO: 0.271 NO_2: 0.0376 PM_{10}: 0.00265 SO_2: 0.00249	TRU: 950 LLW: 800 MLLW: 10 Haz: 750	Construction: 414 Operations: 335	4.5	Construction (workforce) Dose: 0 LCFs: 0 Operations Dose Public: 7.8×10^{-3} Workers: 242 LCFs Public: 3.9×10^{-5} Workers: 0.97	Nuclear criticality at immobilization facility: 2.7×10^{-3} LCF	

Table 2–4. Summary of Impacts of Construction and Operation of Surplus Plutonium Disposition Facilities by Alternative and Site

Site	Air Quality[a] (incremental pollutant concentrations in $\mu g/m^3$)	Waste Management[b] (m^3)	Employment[c] (direct)	Land Disturbance[d] (ha)	Human Health Risk[e] (dose in person-rem)	Facility Accidents[f]	Transportation[g]
Alternative 9: Pit Conversion and MOX in New Construction at Pantex, and Immobilization in New Construction and DWPF at SRS							
Pantex	CO: 0.705 NO_2: 0.0736 PM_{10}: 0.00531 SO_2: 0.00265	TRU: 860 LLW: 1,500 MLLW: 40 Haz: 50	Construction: 1,048 Operations: 785	17	Construction (workforce) Dose: 0 LCFs: 0 Operations Dose Public: 0.61 Workers: 214 LCFs Public: 3.0×10^{-3} Workers: 0.86	Tritium release at pit conversion facility: 1.8×10^{-2} LCF	LCFs: 8.1×10^{-2} Traffic fatalities: 5.2×10^{-2} Kilometers traveled: 4.8M Additional risk of LCFs at Pantex: 0
SRS	CO: 0.152 NO_2: 0.0242 PM_{10}: 0.00181 SO_2: 0.0442	TRU: 950 LLW: 810 MLLW: 10 Haz: 890	Construction: 1,014 Operations: 335	15 Disturbance could impact a site potentially eligible for the National Register of Historic Places	Construction (workforce) Dose: 1.5 LCFs: 6.0×10^{-4} Operations Dose Public: 2.8×10^{-3} Workers: 242 LCFs Public: 1.4×10^{-5} Workers: 0.97	Nuclear criticality at immobilization facility: 8.0×10^{-4} LCF	

Table 2–4. Summary of Impacts of Construction and Operation of Surplus Plutonium Disposition Facilities by Alternative and Site

Site	Air Quality[a] (incremental pollutant concentrations in $\mu g/m^3$)	Waste Management[b] (m^3)	Employment[c] (direct)	Land Disturbance[d] (ha)	Human Health Risk[e] (dose in person-rem)	Facility Accidents[f]	Transportation[g]
Alternative 10: Pit Conversion and MOX in New Construction at Pantex, and Immobilization in FMEF and HLWVF at Hanford							
Pantex	CO: 0.705 NO_2: 0.0736 PM_{10}: 0.00531 SO_2: 0.00265	TRU: 860 LLW: 1,500 MLLW: 40 Haz: 50	Construction: 1,048 Operations: 785	17	Construction (workforce) Dose: 0 LCFs: 0 Operations Dose Public: 0.61 Workers: 214 LCFs Public: 3.0×10^{-3} Workers: 0.86	Tritium release at pit conversion facility: 1.8×10^{-2} LCF	LCFs: 4.6×10^{-2} Traffic fatalities: 4.3×10^{-2} Kilometers traveled: 3.6M Additional risk of LCFs at Pantex: 0
Hanford	CO: 0.271 NO_2: 0.0376 PM_{10}: 0.00265 SO_2: 0.00249	TRU: 950 LLW: 800 MLLW: 10 Haz: 750	Construction: 414 Operations: 335	4.5	Construction (workforce) Dose: 0 LCFs: 0 Operations Dose Public: 7.8×10^{-3} Workers: 242 LCFs Public: 3.9×10^{-5} Workers: 0.97	Nuclear criticality at immobilization facility: 2.7×10^{-3} LCF	

Table 2–4. Summary of Impacts of Construction and Operation of Surplus Plutonium Disposition Facilities by Alternative and Site

Site	Air Quality[a] (incremental pollutant concentrations in $\mu g/m^3$)	Waste Management[b] (m^3)	Employment[c] (direct)	Land Disturbance[d] (ha)	Human Health Risk[e] (dose in person-rem)	Facility Accidents[f]	Transportation[g]
Alternative 11A: Pit Conversion in FMEF and Immobilization in FMEF and HLWVF at Hanford (No MOX)							
Hanford	CO: 0.548 NO_2: 0.0729 PM_{10}: 0.0044 SO_2: 0.00401	TRU: 1,400 LLW: 1,700 MLLW: 20 Haz: 770	Construction: 463 Operations: 812	11	Construction (workforce) Dose: 0 LCFs: 0 Operations Dose Public: 6.9 Workers: 490 LCFs Public: 3.4×10^{-2} Workers: 2.0	Tritium release at pit conversion facility: 0.11 LCF	LCFs: 7.4×10^{-2} Traffic fatalities: 5.4×10^{-2} Kilometers traveled: 3.7M Additional risk of LCFs at Pantex: 8.3×10^{-2}

Table 2–4. Summary of Impacts of Construction and Operation of Surplus Plutonium Disposition Facilities by Alternative and Site

Site	Air Quality[a] (incremental pollutant concentrations in $\mu g/m^3$)	Waste Management[b] (m^3)	Employment[c] (direct)	Land Disturbance[d] (ha)	Human Health Risk[e] (dose in person-rem)	Facility Accidents[f]	Transportation[g]
Alternative 11B: Pit Conversion in New Construction at Pantex and Immobilization in FMEF and HLWVF at Hanford (No MOX)							
Pantex	CO: 0.381 NO_2: 0.0374 PM_{10}: 0.00215 SO_2: 0.00064	TRU: 180 LLW: 600 MLLW: 10 Haz: 20	Construction: 451 Operations: 400	5.0	Construction (workforce) Dose: 0 LCFs: 0 Operations Dose Public: 0.58 Workers: 192 LCFs Public: 2.9×10^{-3} Workers: 0.77	Tritium release at pit conversion facility: 1.8×10^{-2} LCF	LCFs: 7.07×10^{-2} Traffic fatalities: 4.5×10^{-2} Kilometers traveled: 2.5M Additional risk of LCFs at Pantex: 0
Hanford	CO: 0.271 NO_2: 0.0376 PM_{10}: 0.00265 SO_2: 0.00249	TRU: 1,300 LLW: 1,100 MLLW: 10 Haz: 750	Construction: 414 Operations: 367	4.5	Construction (workforce) Dose: 0 LCFs: 0 Operations Dose Public: 1.6×10^{-2} Workers: 266 LCFs Public: 8.0×10^{-5} Workers: 1.1	Nuclear criticality at immobilization facility: 2.7×10^{-3} LCF	

Table 2–4. Summary of Impacts of Construction and Operation of Surplus Plutonium Disposition Facilities by Alternative and Site

Site	Air Quality[a] (incremental pollutant concentrations in $\mu g/m^3$)	Waste Management[b] (m^3)	Employment[c] (direct)	Land Disturbance[d] (ha)	Human Health Risk[e] (dose in person-rem)	Facility Accidents[f]	Transportation[g]
Alternative 12A: Pit Conversion in New Construction and Immobilization in New Construction and DWPF at SRS (No MOX)							
SRS	CO: 0.246 NO_2: 0.0529 PM_{10}: 0.00364 SO_2: 0.0852	TRU: 1,500 LLW: 1,700 MLLW: 20 Haz: 910	Construction: 1,196 Operations: 751	20 Disturbance could impact a site potentially eligible for the National Register of Historic Places	Construction (workforce) Dose: 2.9 LCFs: 1.2×10^{-3} Operations Dose Public: 1.6 Workers: 446 LCFs Public: 8.0×10^{-3} Workers: 1.8	Tritium release at pit conversion facility: 5.0×10^{-2} LCF	LCFs: 0.152 Traffic fatalities: 8.1×10^{-2} Kilometers traveled: 4.4M Additional risk of LCFs at Pantex: 8.3×10^{-2}

Table 2–4. Summary of Impacts of Construction and Operation of Surplus Plutonium Disposition Facilities by Alternative and Site

Site	Air Quality[a] (incremental pollutant concentrations in $\mu g/m^3$)	Waste Management[b] (m^3)	Employment[c] (direct)	Land Disturbance[d] (ha)	Human Health Risk[e] (dose in person-rem)	Facility Accidents[f]	Transportation[g]
Alternative 12B: Pit Conversion in New Construction at Pantex, and Immobilization in New Construction and DWPF at SRS (No MOX)							
Pantex	CO: 0.381 NO_2: 0.0374 PM_{10}: 0.00215 SO_2: 0.00064	TRU: 180 LLW: 600 MLLW: 10 Haz: 20	Construction: 451 Operations: 400	5.0	Construction (workforce) Dose: 0 LCFs: 0 Operations Dose Public: 0.58 Workers: 192 LCFs Public: 2.9×10^{-3} Workers: 0.77	Tritium release at pit conversion facility: 1.8×10^{-2} LCF	LCFs: 0.148 Traffic fatalities: 7.8×10^{-2} Kilometers traveled: 3.9M Additional risk of LCFs at Pantex: 0
SRS	CO: 0.152 NO_2: 0.0242 PM_{10}: 0.00181 SO_2: 0.0442	TRU: 1,300 LLW: 1,100 MLLW: 10 Haz: 890	Construction: 1,014 Operations: 351	15 Disturbance could impact a site potentially eligible for the National Register of Historic Places	Construction (workforce) Dose: 1.5 LCFs: 6.0×10^{-4} Operations Dose Public: 5.8×10^{-3} Workers: 254 LCFs Public: 2.9×10^{-5} Workers: 1.0	Nuclear criticality at immobilization facility: 8.0×10^{-4} LCF	

Table 2–4. Summary of Impacts of Construction and Operation of Surplus Plutonium Disposition Facilities by Alternative and Site

[a] Values represent the incremental criteria pollutant concentrations associated with surplus plutonium disposition operations for the annual averaging period for nitrogen dioxide (NO_2), particulate matter with an aerodynamic diameter smaller than or equal to 10 microns (PM_{10}), and sulfur dioxide (SO_2), and for the 8-hour averaging period for carbon monoxide.

[b] Values are based on a construction period of approximately 3 years and 10 years of operation.

[c] Values are for the peak year of construction for each site and for the annual operation of all facilities for each alternative. Personnel needed to operate the planned HLW vitrification facility at Hanford, or DWPF at SRS, are not included.

[d] Values represent the total land disturbance at each site from construction and operations.

[e] Values for Alternative 1 represent impacts over 50 years of operation under No Action. Those for the remaining alternatives are for the period of construction and 10 years of operation. Public dose values represent the annual radiological dose (in person-rem) to the population within 80 km (50 mi) of the facility location for the year 2030 under Alternative 1, or for 2010 under Alternatives 2 through 12. Worker dose values represent the total radiological dose to involved workers at the facility (in person-rem/year). Public LCFs represent the 50-year LCFs estimated to occur in the population within 80 km (50 mi) for the year 2030 under Alternative 1, or the 10-year LCFs estimated to occur for the year 2010 under Alternatives 2 through 12. Worker LCFs represent the associated 50-year or 10-year LCFs estimated to occur in the involved workforce.

[f] The most severe of the design basis accidents (based on 95 percent meteorological conditions) is used to obtain the population LCF. Higher LCFs would be associated with postulated beyond-design-basis accidents as presented in Chapter 4 and described in detail in Appendix K.

[g] For alternatives that involve more than one site, the transportation impacts for the entire alternative are shown in the first site listed in the alternative. LCFs are from the radiological exposure associated with incident-free operations, radiological accidents, and fatalities expected as a result of vehicle emissions. Traffic fatalities are from nonradiological vehicle accidents. LCFs at Pantex are associated with repackaging requirements if the pit conversion facility were located elsewhere.

[h] Alternatives 3B, 5B, 6C, 6D, 7B, 9B, 12B, and 12D in the SPD Draft EIS have been deleted. Alternative 12C has been renumbered as 12B. Table entries for deleted alternatives have likewise been deleted.

Key: DWPF, Defense Waste Processing Facility; FMEF, Fuels and Materials Examination Facility; FPF, Fuel Processing Facility; Haz, hazardous; HLWVF, high-level-waste vitrification facility; LCF, latent cancer fatality; LLW, low-level waste; MLLW, mixed low-level waste; NA, not applicable; TRU, transuranic.

2.18.2 Summary of Lead Assembly Fabrication and Postirradiation Examination Impacts

The impacts on key resources from fabrication of lead assemblies at the five candidate sites (ANL–W, Hanford, LLNL, LANL, and SRS) evaluated in Section 4.27 are summarized in Table 2–5. These areas include waste management, human health risk during normal operations, facility accidents, and transportation. The transportation analysis includes the shipment of plutonium dioxide from LANL to the candidate site; depleted uranium hexafluoride from the representative DOE storage site at the Portsmouth Gaseous Diffusion Plant to the representative conversion facility in Wilmington, North Carolina; uranium dioxide from the conversion facility to the lead assembly fabrication facility; MOX fuel rods from the lead assembly facility to the McGuire reactor for irradiation; and irradiated fuel rods from McGuire to a postirradiation examination facility.[32] Total distance traveled, in kilometers, is provided for each proposed fabrication site. Because facility modification activities would occur inside existing buildings (i.e., no new buildings would be constructed and no additional land would be disturbed), there should be little increase in air pollutants; land disturbances would be minimal; and the number of construction workers would be low. Little or no impacts are expected on any other resources areas.

Impacts from lead assembly and postirradiation examination activities are based on the fabrication of 10 assemblies, although it is likely that only 2 would be needed. If less than 10 lead assemblies were fabricated, the impacts would be lower than those presented in this SPD EIS. Impacts from facility modifications would not be expected to change because the facility modifications would be the same regardless of the number of assemblies produced. Impacts from routine operations, such as resources used, personnel exposure, waste generation, and transportation, would be expected to be reduced in proportion to the number of assemblies produced. The consequences of facility and transportation accidents would be expected to remain the same because the material at risk at any one time would likely not change. However, the risk of these accidents occurring would be reduced as the number of lead assemblies decreased.

There are no appreciable differences in environmental impacts among the five lead assembly candidate sites. There would be little difference in the volume of waste generated at any of the sites. The small differences in TRU waste and LLW would be due to wastes generated during modification of contaminated areas of existing buildings at ANL–W and LANL. In addition, less than 5 m^3 (6.5 ft^3) of hazardous waste would be generated during facility modification and lead assembly fabrication. The total amount of nonhazardous waste generated, primarily sanitary wastewater, would range from 8,700 to 13,500 m^3 (11,380 to 17,658 yd^3). No LCFs for either workers or the public would be expected to result from fabrication of lead assemblies at any of the proposed locations during routine operations. Impacts from facility accidents also show that no LCFs would be expected in the general population at any site from the postulated bounding design basis accident. Comparison of transportation impacts shows little differences among the sites, with no expected traffic fatalities or LCFs. Likewise, there are not expected to be any appreciable differences between the two postirradiation examination sites.

No major consequences for the maximally exposed involved worker would be expected from leaks, spills, and smaller fires. These accidents are such that involved workers would either be able to evacuate immediately or would not be affected by the events. Explosions, on the other hand, could result in immediate injuries from flying debris, as well as the uptake of plutonium and uranium particulates through inhalation. If a criticality were to occur, workers within tens of meters could receive very high to fatal radiation exposures from the initial burst. The dose would strongly depend on the magnitude of the criticality (number of fissions), the distance from the criticality, and the amount of shielding provided by the structures and equipment between the workers and the criticality. Beyond-design-basis earthquakes would also have substantial consequences, ranging from workers

[32] Shipments of spent fuel to the potential geologic repository are analyzed in the *Draft Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada* (DOE/EIS-0250D) (DOE 1999b).

being killed by debris from collapsing equipment and structures to high radiation exposures and uptakes of radionuclides. For most accidents, immediate emergency response actions should reduce the consequences to workers near the accident.

The impacts of postirradiation examination at ANL–W and ORNL, as evaluated in Section 4.27.6, would be minimal. No construction waste would be generated. With the exception of nonhazardous wastewater at ANL–W, all categories of waste generated during routine operations would use less than 1 percent of either site's applicable treatment, storage, and disposal capacity. Nonhazardous wastewater at ANL–W would use about 6 percent of that site's applicable capacity. Transportation impacts for postirradiation examination at ANL–W are included in the lead assembly impacts presented in Table 2–5. Transportation impacts for postirradiation examination at ORNL would be lower than those listed in Table 2–5 because the distance traveled would be less.

Table 2–5. Summary of Impacts of Lead Assembly Fabrication at the Candidate Sites[a]

Candidate Site	Waste Management[b] (m^3)	Human Health Risk[c] (dose in person-rem)	Facility Accidents[d]	Transportation[e]
ANL–W	Total TRU waste: 132 Total LLW: 736 Total MLLW: 4 Total Haz: 0	Dose Public: 0.011 Workers: 28 LCFs Public: 5.5×10^{-6} Workers: 0.011	Nuclear criticality LCFs: 1.7×10^{-4}	Radiological LCFs: 8.1×10^{-3} Traffic fatalities: 1.8×10^{-3} Kilometers traveled: 77,000
Hanford	Total TRU waste: 132 Total LLW: 700 Total MLLW: 4 Total Haz: 0	Dose Public: 0.025 Workers: 28 LCFs Public: 1.2×10^{-5} Workers: 0.011	Nuclear criticality LCFs: 2.7×10^{-3}	Radiological LCFs: 8.1×10^{-3} Traffic fatalities: 1.9×10^{-3} Kilometers traveled: 89,000
LLNL	Total TRU waste: 132 Total LLW: 700 Total MLLW: 4 Total Haz: 0	Dose Public: 1.1 Workers: 28 LCFs Public: 5.5×10^{-4} Workers: 0.011	Nuclear criticality LCFs: 3.2×10^{-2}	Radiological LCFs: 8.4×10^{-3} Traffic fatalities: 1.8×10^{-3} Kilometers traveled: 73,000
LANL	Total TRU waste: 137 Total LLW: 705 Total MLLW: 4 Total Haz: 0	Dose Public: 0.025 Workers: 28 LCFs Public: 1.2×10^{-5} Workers: 0.011	Nuclear criticality LCFs: 3.2×10^{-3}	Radiological LCFs: 8.1×10^{-3} Traffic fatalities: 1.6×10^{-3} Kilometers traveled: 49,000
SRS	Total TRU waste: 132 Total LLW: 700 Total MLLW: 4 Total Haz: 2	Dose Public: 6.6×10^{-3} Workers: 28 LCFs Public: 3.3×10^{-6} Workers: 0.011	Nuclear criticality LCFs: 6.5×10^{-4}	Radiological LCFs: 8.3×10^{-3} Traffic fatalities: 1.6×10^{-3} Kilometers traveled: 67,000

[a] Impacts are based on the fabrication of 10 lead assemblies and irradiation of 8. Should only two lead assemblies be fabricated and irradiated, impacts would be lower than indicated.

[b] Totals for 2-year modification and 3-year operation of lead assembly facility.

[c] Annual dose for public residing within 80 km (50 mi) of the candidate site. Worker dose is the same at all five facilities because estimated number of workers and estimated dose to worker does not vary by site. Estimated dose to public varies based on projected population within 80 km (50 mi) of candidate site.

[d] The most severe of the design basis accidents is listed.

[e] LCFs are from the radiological exposure associated with incident-free operations and radiological accidents; traffic fatalities, from nonradiological traffic accidents.

Key: ANL–W, Argonne National Laboratory–West; LANL, Los Alamos National Laboratory; LCF, latent cancer fatality; LLNL, Lawrence Livermore National Laboratory; LLW, low-level waste; MLLW, mixed-low-level waste; TRU, transuranic.

No LCFs would be expected to either workers or the public from routine postirradiation examination activities. There would be no routine releases of radioactivity to the environment, and thus, radiological impacts on the public. The average annual dose to facility workers would be 177 mrem, for an annual dose to the total facility

workforce of 1.8 person-rem. The most severe accident would be a nuclear criticality. Such an accident could result in high, though probably not fatal, radiological exposures to hot cell workers. No LCFs would be expected in the general population.

If DOE were to decide to immobilize all 50 t (55 tons) of surplus plutonium, no lead assembly activities would be required. Should DOE decide to pursue the MOX option, but to not fabricate lead assemblies, such activities would not occur at any of the five sites. Under both of these scenarios, current operations would continue at the sites and the environmental conditions would remain at baseline levels. (See Chapter 3 for a description of the current environmental conditions at the sites.)

2.18.3 MOX Fuel Integrated Impacts

The impacts from implementing the MOX fuel fabrication alternatives would not be limited to those associated with the MOX facility, but would also include impacts from lead assembly fabrication, irradiation, and postirradiation examination, and the use of reactors for irradiation of the MOX fuel assemblies. Any new construction would occur at existing DOE sites. MOX-related operations at all sites would be compatible with, or similar to, activities already occurring at those locations.

Tables 2–6 through 2–11 describe the potential impacts of implementation of the MOX alternatives, from fabrication of the MOX fuel assemblies and lead assemblies to irradiation of the assemblies in domestic, commercial reactors, and the transportation for all radioactive material movements. While these impacts would be cumulative over the life of the campaign, they would not all be concurrent. The data presented are those reported in Chapter 4.

Air emissions, presented in Table 2–6, would result primarily from building heating and vehicular emissions. Releases of criteria pollutants are provided as a range, with the lowest emissions at Hanford, where electricity is the method of heating, and the highest at INEEL, where coal-fired boilers produce steam for heating and travel distances for personnel result in vehicular emissions double those estimated for other candidate sites. Lead assembly fabrication and postirradiation examination activities are relatively small efforts that are not expected to measurably increase air emissions at any of the candidate sites. There are no nonradiological emissions from these facilities that are regulated under the National Emission Standards for Hazardous Air Pollutants (NESHAPs). As discussed in Section 4.32, radiological NESHAPs emissions would be monitored and maintained as part of the total site limit of 10 mrem/yr from all sources. There would be no incremental difference in the air emissions from Catawba, McGuire, or North Anna related to using MOX fuel. Criteria, toxic, and hazardous pollutant emissions are not related to the type of reactor fuel. Rather, emission of these pollutants from the reactor sites would be related to ancillary processes such as operation of diesel generators, periodic testing of emergency diesel generators, and facility operations.

TRU waste and LLW would be generated during operation of both the lead assembly and full-scale MOX facilities (see Table 2–7). The amount of waste generated would be process-specific, and would not vary appreciably by site. Lead assembly fabrication would result in a total of 132 m^3 (173 yd^3) of TRU waste and 700 m^3 (916 yd^3) of LLW waste. The larger amount of waste generated on an annual basis by lead assembly fabrication, as compared to full-scale fabrication, would be attributed to operational differences between fabricating MOX fuel on a laboratory rather than commercial scale. Similarly, activities such as material recycle may not be implemented to as great an extent on the smaller scale. No increase is expected in the amount of waste generated at the reactor sites as a result of using MOX fuel.

Table 2–6. Potential Impacts on Air Quality of MOX Fuel Fabrication and Irradiation

Criteria Pollutant	MOX Facility[a] (kg/yr)	L.A. Fab. and Postirrad. Exam. (kg/yr)	Reactor Operation Increment (kg/yr)	Total MOX Fuel Increment (kg/yr)
Carbon monoxide	35K to 83K	0	0	35K to 83K
Nitrogen dioxide	11K to 32K	0	0	11K to 32K
PM_{10}	31K to 60K	0	0	31K to 60K
Sulfur dioxide	0.1K to 73K	0	0	0.1K to 73K
Volatile organic compounds	4K to 10K	0	0	4K to 10K
Total suspended particulates[b]	31K to 60K	0	0	31K to 60K

[a] Includes vehicle emissions.
[b] Total suspended particulates assumed to be the same as PM_{10}.
[Text deleted.]

Table 2–7. Potential Impacts on Waste Generation of MOX Fuel Fabrication and Irradiation

Waste Type	MOX Facility (m^3)	L.A. Fab. and Postirrad. Exam. (m^3)	Reactor Operation Increment	Total MOX Fuel Increment[a] (m^3)
TRU waste	680	143	0	823
Low-level waste	940	840	0	1,780
Mixed LLW	30	5	0	35
Hazardous	30	1	0	31
Nonhazardous				
Liquid[b]	260K	7.9K	0	268K
Solid	4.4K	5.3K	0	9.7K

[a] Total contribution of MOX effort; based on total lead assembly and postirradiation examination activities and 10 years of MOX fuel fabrication.
[b] Primary contributor is sanitary use, not process-related activities.

More spent fuel would be generated at the reactor sites as a result of the proposed disposition of surplus plutonium as MOX fuel. As discussed in Section 4.28, it is expected that approximately 5 percent additional spent fuel would be generated as a result of MOX fuel irradiation at the proposed reactor sites. Even so, there would be sufficient space at the reactor sites (in either the spent fuel pools or dry storage) to store the additional spent fuel until it could be sent to a potential geologic repository pursuant to the NWPA. DOE's draft environmental impact statement for a potential geologic repository (DOE/EIS-0250D, July 1999) includes the MOX fuel that would be generated from this program.

Existing infrastructure would be adequate to support the MOX fuel alternatives, although it has been estimated that up to 2 km (0.62 mi) of new roads would be needed for the MOX facility (see Table 2–8). Consumption of coal, natural gas, and electricity vary greatly from site to site, for both the MOX and the lead assembly fabrication facilities, depending on the type of fuel used for heating. For example, electricity needed for MOX fuel fabrication would be 30,000 MWh/yr at all sites but Hanford. Hanford, which is estimated to use one and one-half times the electricity of the other sites (46,000 MWh/yr), uses electricity to heat its buildings. INEEL and SRS use coal for heating, and Pantex, natural gas. No additional infrastructure needs would result from the use of MOX fuel at the proposed reactors.

Table 2–9 compiles information about expected radiological impacts on workers during routine operations. The impacts on workers at the MOX facility are based on operating experience at existing MOX facilities in

Table 2–8. Potential Impacts on Infrastructure of MOX Fuel Fabrication and Irradiation

Requirement	MOX Facility	L.A. Fab. and Postirrad. Exam.	Reactor Operation Increment
Electricity (MWh/yr)	30K to 46K	0.7K to 1.2K	0
Water (l/yr)	68M	1.6M	0
Fuel			
Oil (l/yr)	63K	12K to 61K	0
Natural gas (m^3/yr)	0 to 1.1M	0 to 55K	0
Coal (t/yr)	0 to 2.1K	0 to 0.06K	0
Transportation			
Roads (km)	1.0 to 2.0	0	0
Rail (km)	0	0	0

Table 2–9. Potential Radiological Impacts on Workers of MOX Fuel Fabrication and Irradiation

Impact	MOX Facility (over 10 years)	L.A. Fab. and Postirrad. Exam. (over 6 years)	Reactor Operation Increment (over 16 years)
Average worker dose (mrem/yr)	65	451	0
Latent fatal cancer risk	2.6×10^{-4}	1.1×10^{-3}	0
Total dose (person-rem/yr)	22	15	0
Latent fatal cancers	0.088	0.035	0

Europe (DOE 1999a). Impacts on workers at the postirradiation examination facility are based on operating experience at ORNL (O'Connor et al. 1998a). The impacts at the lead assembly fabrication facilities are based on an average annual dose rate of 500 mrem/yr. (This is an administrative limit that has been set in accordance with as-low-as-is-reasonably-achievable principles.) The exposure over the life of the MOX campaign (10 years for the MOX facility, 3 years for lead assembly fabrication and 3 years for postirradiation examination) would result in an increased risk of fatal cancer of 2.6×10^{-4} at the MOX facility, 6.0×10^{-4} at the lead assembly site, and 2.2×10^{-4} at the postirradiation examination facility. The corresponding number of LCFs for MOX facility, lead assembly, and postirradiation examination workers from the MOX campaign would be 0.088, 0.033, and 0.002, respectively. No increase in the incremental dose to workers is expected at the proposed reactors from using MOX fuel.

The potential radiological impacts on the general population from routine operations would be very small. Table 2–10 shows that from routine operations annual doses from the MOX facility to the maximally exposed individual (MEI) range from 1.8×10^{-3} to 1.5×10^{-2} mrem/yr, which translates to an increased risk of fatal cancer of 9.0×10^{-9} to 7.5×10^{-8} for 10 years of exposure. The lowest dose would be received at Hanford; the highest, Pantex. However, the population around Pantex would receive the lowest total population dose, and the lowest annual dose to the average individual. Estimated results at Hanford would be at the high end of the range for both of these parameters, 2.9×10^{-1} person-rem/yr and 7.5×10^{-4} mrem/yr, respectively. The annual dose to the average individual would still be extremely small, and would result in only a 3.8×10^{-9} increased risk of fatal cancer for 10 years of exposure. Offsite dose to the MEI resulting from lead assembly fabrication ranges from a low at SRS of 5.5×10^{-5} to 6.4×10^{-2} mrem/yr at LLNL. The associated risk of fatal cancer would be extremely low for the same MEI, ranging from 8.3×10^{-11} to 9.6×10^{-8}. Annual doses to the average individual at SRS and LLNL would be 8.8×10^{-6} and 1.4×10^{-4} mrem, respectively; risk of LCFs to the same individuals would be 1.3×10^{-11} and 2.1×10^{-10}. Offsite dose to the MEI resulting from postirradiation examination would not be expected to change because the activities would not be additive, but would displace similar activities already being done in these facilities. No change would be expected in the radiation dose to the general population from normal operations associated with the disposition of MOX fuel at the proposed reactors (see Table 2–10).

Table 2–10. Potential Radiological Impacts on the Public of MOX Fuel Fabrication and Irradiation

Impact	MOX Facility (over 10 years)	L.A. Fab. and Postirrad. Exam. (over 6 years)	Reactor Operation Increment (over 16 years)
Annual dose to MEI (mrem)	1.8×10^{-3} to 1.5×10^{-2}	0 to 6.4×10^{-2}	0
Fatal cancer risk	9.0×10^{-9} to 7.5×10^{-8}	0 to 9.6×10^{-8}	0
Annual population dose (person-rem)	0.027 to 0.29	0 to 1.1	0
Fatal cancers	1.4×10^{-4} to 1.5×10^{-3}	0 to 1.7×10^{-3}	0
Annual dose to average ind. (mrem)	8.8×10^{-5} to 7.5×10^{-4}	0 to 1.4×10^{-4}	0
Fatal cancer risk	4.4×10^{-10} to 3.8×10^{-9}	0 to 2.1×10^{-10}	0

Transportation impacts are summarized in Table 2–11, and include radiological dose to the truck crew and the general population, nonradiological emissions from vehicle operation, potential traffic accident fatalities, and LCFs resulting from an accident involving a breach of containment and release of radioactive materials. Shipments analyzed include all those listed in Table 2–3 for the MOX, lead assembly, and postirradiation examination facilities, and shipments of fresh MOX fuel to the proposed reactor sites. The analysis shows that no traffic fatalities or LCFs would be expected from either routine transportation activities or accidents.

Table 2–11. Potential Overland Transportation Risks of MOX Fuel Fabrication and Irradiation

Impact	MOX Facility	L.A. Fab. and Postirrad. Exam.	Total MOX Fuel Increment
Routine radiological			
Crew (LCFs)	6.7×10^{-4} to 1.1×10^{-3}	7.1×10^{-5} to 5.6×10^{-4}	7.4×10^{-4} to 1.6×10^{-3}
Public (LCFs)	5.3×10^{-3} to 7.2×10^{-3}	6.0×10^{-4} to 4.8×10^{-3}	5.9×10^{-3} to 1.2×10^{-2}
Routine nonradiological, emissions (LCFs)	6.2×10^{-3} to 2.3×10^{-2}	7.7×10^{-5} to 3.7×10^{-4}	6.2×10^{-3} to 2.4×10^{-2}
Accidental, traffic (fatalities)	1.7×10^{-2} to 5.9×10^{-2}	4.7×10^{-4} to 1.9×10^{-3}	1.8×10^{-2} to 6.1×10^{-2}
Accidental, radiological (LCFs)	3.2×10^{-3} to 3.8×10^{-3}	5.6×10^{-4} to 3.0×10^{-3}	3.8×10^{-3} to 6.8×10^{-3}

Key: LCFs, latent cancer fatalities.

Accidents are unplanned events which would be different for each type of facility needed to implement the MOX approach. The accidents analyzed for the disposition facilities are presented in detail in Appendix K and the consequences summarized by alternative in Chapter 4 (Sections 4.3 through 4.19 for Alternative 2 through 10, respectively, Section 4.27 for the lead assembly and postirradiation examination alternatives, and Section 4.28 for the reactors). The design basis accident with the most severe consequences postulated for the MOX facility is a criticality. This accident would result in an estimated dose at a distance of 1 km (0.62 mi) from the facility of from 0.15 rem at Hanford to 0.75 rem at INEEL. This same accident would result in doses at the site boundaries ranging from 1.6×10^{-2} rem at INEEL and SRS to 4.7×10^{-2} rem at Pantex. Population doses and LCFs within 80 km (50 mi) would range from 1.0 person-rem and 5.2×10^{-4} LCF at INEEL to 55 person-rem and 2.8×10^{-2} LCF at Hanford. The frequency of such an accident is estimated to be between 1 in 10,000 and 1 in 1,000,000 per year.

The postulated design basis accident with the most severe consequences for proposed lead assembly operations using MOX fuel would be associated with a nuclear criticality. The accident would result in an incremental increase in estimated dose at the site boundaries ranging from 9.3×10^{-4} rem at SRS to 5.3×10^{-1} rem at LLNL. The same accident would result in incremental changes in population doses and LCF probabilities within 80 km (50 mi), ranging from 3.4×10^{-1} person-rem and 1.6×10^{-4} LCF at ANL–W to 6.6 person-rem and 3.2×10^{-3} LCF at LANL, respectively. The frequency of such an accident is estimated to be between 1 in 10,000 and 1 in 1,000,000 per year. A nuclear criticality would also be the most severe accident at the postirradiation

examination facilities, but the amount of spent fuel necessary for such an accident to be physically possible is at least one to two orders of magnitude greater than would normally be available.

The design basis accident with the most severe consequences postulated for the proposed reactors using MOX fuel is a loss-of-coolant accident. This accident would result in an increase in the estimated dose at a distance of 640 m (2,100 ft) from the reactor of 0.001 rem at North Anna to 0.15 rem at McGuire. The same accident would result in incremental increases in doses at the site boundaries ranging from 2.0×10^{-4} rem at North Anna to 0.06 rem at McGuire. The incremental change in population doses and LCFs within 80 km (50 mi) of the reactors would range from 0.9 person-rem and 5×10^{-4} LCF at North Anna to 110 person-rem and 0.06 LCF at Catawba. The frequency of such an accident is estimated to be between 1 in 48,000 and 1 in 130,000 per year.

This SPD EIS also evaluates the potential impacts from a set of postulated highly unlikely accidents with potentially severe consequences at the proposed reactors using both uranium-only and MOX cores. [Text deleted.] Regarding effects of MOX fuel on accident probabilities, the National Academy of Sciences 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" (NAS 1995:352). Regarding the effects of MOX fuel 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 no 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" (NAS 1995:355).

The incremental effects of using MOX fuel in the proposed reactors in place of LEU fuel were derived from a quantitative analysis of several highly unlikely severe accident scenarios for MOX and LEU fuel. The analysis considers severe accidents where sufficient damage could occur to cause the release of plutonium or uranium through a breach of the plant's containment. The consequences of these accident releases on the general population were found to range from minus 4 to plus 14 percent[33] compared with LEU fuel, depending on the accident release scenario. This analysis was based on existing probabilistic risk assessments of severe accidents, and the release scenarios were modeled assuming projected population distributions near the proposed reactors in 2015.

The highest consequence accident at all three of the proposed reactors is an interfacing systems loss-of-coolant accident. However, there is an extremely small chance that this beyond-design-basis accident would ever occur. The likelihood of this accident occurring is 1 chance in 15 million at Catawba, 1 chance in 1.6 million at McGuire, and 1 chance in 4.2 million at North Anna. Were this accident to occur, the increases in the estimated dose at the site boundary for MOX fuel as compared to LEU fuel would be 2,000 rem at Catawba; 2,400 rem at McGuire; and 2,200 rem at North Anna. These increases are 14 percent, 12 percent, and 22 percent, respectively, above the doses expected from the same accident using LEU fuel. The incremental change in population doses and LCFs within 80 km (50 mi) of the reactors have been estimated to be 3.2×10^{6} person-rem and 1,300 LCFs (from 15,600 to 16,900 LCFs) at Catawba; 1.8×10^{6} person-rem and 800 LCFs (from 11,900 to 12,700) at McGuire; and 7.3×10^{5} person-rem and 410 LCFs (from 2,980 to 3,390 LCFs) at North Anna. Prompt fatalities from this accident would be expected to increase from 815 to 843 at Catawba, from 398 to 421 at McGuire, and from 54 to 60 at North Anna. The increase in risk to the population from this accident as a result of using MOX

[33] Accidents severe enough to cause a release of plutonium involve combinations of events that are highly unlikely. Estimates and analyses presented in Section 4.28 indicate an incremental range of postulated LCFs due to the use of MOX fuel of minus 7 to plus 1,300 (in the population within 80 km [50 mi] of the release point), with incremental attendant risks of LCFs over 16 years of reactor operation with MOX fuel of minus 1.3×10^{-3} and plus 1.4×10^{-3}, respectively.

fuel would be 1.4×10^{-3} at Catawba, 8.0×10^{-3} at McGuire, and 1.6×10^{-3} at North Anna over the estimated 16-year life of the MOX fuel irradiation program.

[Text deleted.]

2.18.4 Comparison of Immobilization Technology Impacts

To provide a basis for evaluating alternative immobilization forms and technologies, the environmental impacts associated with operating the ceramic and glass can-in-canister immobilization facilities evaluated in this SPD EIS were compared with the corresponding environmental impacts associated with operating the homogenous ceramic immobilization and vitrification facilities evaluated in the *Storage and Disposition PEIS* (DOE 1996a).

Section 4.29 presents the comparable impacts for key environmental resources (e.g., air quality, waste management, human health risk, and resource requirements) at Hanford and SRS for the homogenous ceramic immobilization/vitrification facilities and the can-in-canister immobilization facilities. Impacts associated with facility accidents, intersite transportation, and environmental justice are also discussed. The results of the comparative analysis are summarized here.

The comparison of impacts is based on immobilizing the full 50 t (55 tons) of surplus plutonium. The *Storage and Disposition PEIS* impact analyses are based on operating facilities that would convert the plutonium into an oxide in one new facility and immobilize it into a homogenous ceramic or glass form in another new facility. Impacts for a plutonium conversion facility are evaluated and itemized separately from the impacts for a ceramic immobilization or vitrification facility. In contrast, this SPD EIS considers the use of both new and existing facilities, and is based on a collocated plutonium conversion and immobilization capability. To compare the impacts, it was therefore necessary to combine the separate *Storage and Disposition PEIS* impact values, as appropriate, to establish a suitable standard of comparison.

Generally, air quality impacts associated with the ceramic or glass can-in-canister technologies would be lower or about the same as those evaluated in the *Storage and Disposition PEIS* for ceramic immobilization or vitrification. With the exception of sulfur dioxide in the ceramic can-in-canister process, all criteria pollutant concentrations associated with either can-in-canister technology would range from being the same to being much lower. Pollutant levels would not be expected to differ between the ceramic and glass can-in-canister processes.

Potential volumes of most waste types resulting from operation of the ceramic or glass can-in-canister technologies would be considerably less than the waste volumes expected from either ceramic immobilization or vitrification technology evaluated in the *Storage and Disposition PEIS*. For example, operation of a can-in-canister facility using the ceramic process at Hanford or SRS is estimated to result in TRU waste volumes of 126 m^3/yr (165 yd^3/yr), compared to the 647 m^3/yr (846 yd^3/yr) of TRU waste estimated in the *Storage and Disposition PEIS* from operation of the homogenous ceramic immobilization facility. Factors contributing to the reduced waste levels associated with the can-in-canister technology would include the use of dry-feed preparation techniques, coordination with existing HLW vitrification operations and the need for a smaller operating work force. Waste volumes would not be expected to differ appreciably between the ceramic and glass can-in-canister processes.

Section 4.29 also presents the potential radiological exposure and cancer risk to the public and involved workers from normal operation of the immobilization facilities. The potential risks to the public associated with either can-in-canister technology would be slightly higher than the homogeneous technologies at Hanford, but lower at SRS. For example, operation of a can-in-canister facility using the ceramic process at Hanford or SRS is estimated to result in population doses of 1.6×10^{-2} or 5.8×10^{-3} person-rem/yr, respectively, compared to the

population doses of 8.4×10^{-3} (at Hanford) or 6.6×10^{-2} person-rem/yr (at SRS) resulting from operation of the homogenous ceramic immobilization facility evaluated in the *Storage and Disposition PEIS*. These variations may be attributable to the incorporation of updated source terms, meteorology, population distribution, and other modeling variables in the analysis of the can-in-canister technologies. A comparison between the ceramic and glass can-in-canister technologies indicates operation of the ceramic process would result in slightly higher potential offsite impacts, regardless of whether it is located at Hanford or SRS. For example, the dose associated with operation of the can-in-canister facility at Hanford would result in a population dose of 1.6×10^{-2} person-rem/yr using the ceramic process and 1.5×10^{-2} person-rem/yr using the glass process; the same facility at SRS would result in a population dose of 5.8×10^{-3} person-rem/yr using the ceramic process, and a dose of 5.3×10^{-3} person-rem/yr using the glass process.

The estimated average worker dose and associated cancer risk for the can-in-canister technologies are slightly higher than estimated in the *Storage and Disposition PEIS* for the homogenous technologies. In all cases, however, worker dose would be within the DOE design objective of 1,000 mrem/yr. Potential radiological impacts on involved workers are not expected to differ appreciably between the ceramic and glass can-in-canister processes.

Although some potential hazardous chemical impacts were determined for the homogenous ceramic immobilization/vitrification technologies evaluated in the *Storage and Disposition PEIS*, none are expected for either the ceramic or glass can-in-canister technology because no hazardous chemical emissions would occur from operations.

Because of substantial differences between the *Storage and Disposition PEIS* and the SPD EIS in terms of the specific accident scenarios and supporting assumptions used in the determination of facility accident impacts, a standard basis for comparing homogenous technology and can-in-canister technology accidents is not available. For example, a design basis earthquake scenario was not evaluated in the *Storage and Disposition PEIS* for the plutonium conversion facility, nor were any other design basis accidents evaluated for that facility that could be incorporated with like impacts to the ceramic immobilization or vitrification facility for direct comparison to the accident scenarios presented in this SPD EIS. A design basis earthquake associated with the homogenous approach at Hanford would result in 5.8×10^{-8} and 3.2×10^{-6} LCF in the general population for ceramic immobilization and vitrification, respectively; a design basis earthquake affecting the same facilities at SRS would result in 6.2×10^{-8} and 3.4×10^{-6} LCF, respectively. As discussed earlier in this paragraph these values do not reflect the impact of such accidents on a plutonium conversion facility, and are therefore not directly comparable with the results for the can-in-canister approach shown in this SPD EIS. Comparison of the ceramic and glass can-in-canister processes indicates slightly higher impacts would be associated with the ceramic process. For example, a design basis earthquake at Hanford would result in 9.6×10^{-5} LCF in the general population using the ceramic process, and 8.4×10^{-5} LCF using the glass process. Similarly, a design basis earthquake at SRS would result in 3.6×10^{-5} LCF in the general population using a ceramic process, and 3.1×10^{-5} LCF using a glass process.

In terms of resource requirements, operation of the can-in-canister technologies would require lower amounts of electricity, fuel, land area, and water than would the homogenous technologies evaluated in the *Storage and Disposition PEIS*. Fewer workers would be required to operate the can-in-canister technologies, which in turn would result in lower socioeconomic impacts. Resource requirements differ between the ceramic and glass can-in-canister processes in that electricity requirements would be greater to support the ceramic process at either site (i.e., the ceramic process would require 29,000 or 24,000 MWh/yr at Hanford or SRS, respectively, compared to the 28,500 or 23,000 MWh/yr, respectively, required for the glass process).

The *Storage and Disposition PEIS* analysis assumes that canisters of plutonium immobilized with radionuclides would be transported to a potential geologic repository via rail. This SPD EIS analysis, however, conservatively

assumes that the immobilized canisters would be shipped by truck from the immobilization site to the repository, with one canister being transported per truck shipment.[34] The ceramic and glass can-in-canister technologies would result in fewer total potential fatalities from intersite transportation than would the homogenous ceramic immobilization/vitrification technologies evaluated in the *Storage and Disposition PEIS*. Because the ceramic can-in-canister process would produce fewer canisters, it would result in somewhat lower routine and accidental transportation impacts than the glass can-in-canister process.

Evaluations of both the homogenous ceramic immobilization/vitrification technologies and can-in-canister technologies included routine facility operations and transportation as well as accidents. No significant risk to the general population would be expected to occur for normal operations or in the event of a design basis accident. [Text deleted.] Similarly, implementation of these technologies would not result in a significant risk of disproportionately high and adverse impacts on minority or low-income groups within the general population.

[34] The *Draft Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada* (DOE/EIS-0250D) (DOE 1999b) analyzes spent fuel shipments by rail and truck. No decision has been made as to the mode of transportation.

2.19 REFERENCES

DOE (U.S. Department of Energy), 1996a, *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement*, DOE/EIS-0229, Office of Fissile Materials Disposition, Washington, DC, December.

DOE (U.S. Department of Energy), 1996b, *Tank Waste Remediation System, Hanford Site, Richland, Washington, Final Environmental Impact Statement*, DOE/EIS-0189, Richland Operations Office, Richland, WA, August.

DOE (U.S. Department of Energy), 1997a, *Record of Decision for the Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement*, 62 FR 3014, Office of the Federal Register, Washington, DC, January 14.

DOE (U.S. Department of Energy), 1997b, *Notice of Intent to Prepare a Surplus Plutonium Disposition Environmental Impact Statement*, 62 FR 28009, Office of the Federal Register, Washington, DC, May 22.

DOE (U.S. Department of Energy), 1998a, *Amended Record of Decision for the Storage and Disposition of Weapons-Usable Fissile Materials*, 63 FR 43386, Office of the Federal Register, Washington, DC, August 13.

DOE (U.S. Department of Energy), 1998b, *Environmental Assessment for the Transfer of 1100 Area Southern Rail Connection and Rolling Stock, Hanford Site, Richland, Washington*, DOE/EA-1260, Richland Operations Office, Richland, WA, August.

DOE (U.S. Department of Energy), 1998c, *Independent Assessment of the Savannah River Site High Level Waste Salt Disposition Alternative Evaluation*, DOE/ID-10672, December.

DOE (U.S. Department of Energy), 1999a, *MOX Fuel Fabrication Facility and Nuclear Power Reactor Data Report*, MD-0015, Office of Fissile Materials Disposition, Washington, DC, August.

DOE (U.S. Department of Energy), 1999b, *Draft Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada*, DOE/EIS-0250D, Office of Civilian Radioactive Waste Management, North Las Vegas, NV, July.

DOE (U.S. Department of Energy), 1999c, *Supplement Analysis for Continued Operation of Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore*, DOE/EIS-0157-SA-01, Oakland Operations Office, Oakland, CA, March.

EPA (U.S. Environmental Protection Agency), 1999, *Notice of Availability for the Draft Supplement for Surplus Plutonium Disposition*, 64 FR 26410, Office of the Federal Register, Washington, DC, May 14.

NAS (National Academy of Sciences), 1995, *Management and Disposition of Excess Weapons Plutonium Reactor-Related Option*, National Academy Press, Washington, DC.

NC (National Research Council), 1999, Interim Report on Processing Alternatives for High-Level Radioactive Waste Salt Solutions at the Savannah River Site, transmitted by letter from Milt Levenson, Chair and Greg Choppin, Vice Chair to Ernest J. Moniz, Under Secretary, U.S. Department of Energy, October 14.

O'Connor, D.G., et al., 1998a, *ANL-W MOX Fuel Lead Assemblies Data Report for the Surplus Plutonium Disposition Environmental Impact Statement*, ORNL/TM-13478, Lockheed Martin Energy Research Corporation, Oak Ridge, TN, August.

O'Connor, D.G., et al., 1998b, *LLNL MOX Fuel Lead Assemblies Data Report for the Surplus Plutonium Disposition Environmental Impact Statement*, ORNL/TM-13480, Lockheed Martin Energy Research Corporation, Oak Ridge, TN, August.

O'Connor, D.G., et al., 1998c, *Hanford MOX Fuel Lead Assemblies Data Report for the Surplus Plutonium Disposition Environmental Impact Statement*, ORNL/TM-13481, Lockheed Martin Energy Research Corporation, Oak Ridge, TN, August.

O'Connor, D.G. et al., 1998d, *LANL MOX Fuel Lead Assemblies Data Report for the Surplus Plutonium Disposition Environmental Impact Statement*, ORNL/TM-13482, Lockheed Martin Energy Research Corporation, Oak Ridge, TN, August.

O'Connor, D.G., et al., 1998e, *SRS MOX Fuel Lead Assemblies Data Report for the Surplus Plutonium Disposition Environmental Impact Statement*, ORNL/TM-13483, Lockheed Martin Energy Research Corporation, Oak Ridge, TN, August.

ORNL (Oak Ridge National Laboratory), 1998, *Final Data Report Response to the Draft Surplus Plutonium Disposition Environmental Impact Statement Data Call for Generic Site Add-On Facility for Plutonium Polishing*, ORNL/TM-13669, Oak Ridge, TN, June.

ORNL (Oak Ridge National Laboratory), 1999, *MOX/LEU Core Inventory Ratios*, Oak Ridge, TN.

SRARP (Savannah River Archaeological Research Program), 1989, *Archaeological Resource Management Plan of the Savannah River Archaeological Research Program*, South Carolina Institute of Archaeology and Anthropology, University of South Carolina, Columbia, SC, December.

UC (Regents of the University of California), 1997, *Immobilization Technology Down-Selection Radiation Barrier Approach*, UCRL-ID-127320, Lawrence Livermore National Laboratory, Livermore, CA, May 23.

UC (Regents of the University of California), 1998a, *Pit Disassembly and Conversion Facility, Environmental Impact Statement Data Report—Hanford Site*, LA-UR-97-2907, Los Alamos National Laboratory, Los Alamos, NM, June 1.

UC (Regents of the University of California), 1998b, *Pit Disassembly and Conversion Facility, Environmental Impact Statement Data Report—Idaho National Engineering and Environmental Laboratory*, LA-UR-97-2908, Los Alamos National Laboratory, Los Alamos, NM, June 1.

UC (Regents of the University of California), 1998c, *Pit Disassembly and Conversion Facility, Environmental Impact Statement Data Report—Pantex Plant*, LA-UR-97-2909, Los Alamos National Laboratory, Los Alamos, NM, June 1.

UC (Regents of the University of California), 1998d, *Pit Disassembly and Conversion Facility, Environmental Impact Statement Data Report—Savannah River Site*, LA-UR-97-2910, Los Alamos National Laboratory, Los Alamos, NM, June 1.

UC (Regents of the University of California), 1998e, *Response to the Surplus Plutonium Disposition Environmental Impact Statement Data Call for a Mixed Oxide Fuel Fabrication Facility Located at the Hanford Site*, rev. 3, LA-UR-97-2064, Los Alamos National Laboratory, Los Alamos, NM, June 22.

UC (Regents of the University of California), 1998f, *Response to the Surplus Plutonium Disposition Environmental Impact Statement Data Call for a Mixed Oxide Fuel Fabrication Facility Located at the Idaho National Engineering and Environmental Laboratory*, rev. 3, LA-UR-97-2065, Los Alamos National Laboratory, Los Alamos, NM, June 22.

UC (Regents of the University of California), 1998g, *Response to the Surplus Plutonium Disposition Environmental Impact Statement Data Call for a Mixed Oxide Fuel Fabrication Facility Located at the Pantex Plant*, rev. 3, LA-UR-97-2067, Los Alamos National Laboratory, Los Alamos, NM, June 22.

UC (Regents of the University of California), 1998h, *Response to the Surplus Plutonium Disposition Environmental Impact Statement Data Call for a Mixed Oxide Fuel Fabrication Facility Located at the Savannah River Site*, rev. 3, LA-UR-97-2066, Los Alamos National Laboratory, Los Alamos, NM, June 22.

UC (Regents of the University of California, 1998i, *Cost Estimates of Pit Disassembly and Conversion Facility Siting Alternatives,* LA-13485-MS, Los Alamos National Laboratory, Los Alamos, NM, July.

[Text deleted.]

UC (Regents of the University of California), 1999a, *Fissile Materials Disposition Program, EIS Data Call Report: Plutonium Immobilization Plant Using Ceramic in Existing Facilities at Hanford*, rev. 1, UCRL-ID-128275, Lawrence Livermore National Laboratory, Livermore, CA, September.

UC (Regents of the University of California), 1999b, *Fissile Materials Disposition Program, EIS Data Call Report: Plutonium Immobilization Plant Using Glass in Existing Facilities at Hanford*, rev. 1, UCRL-ID-128276, Lawrence Livermore National Laboratory, Livermore, CA, September.

UC (Regents of the University of California), 1999c, *Fissile Materials Disposition Program, EIS Data Call Report: Plutonium Immobilization Plant Using Glass in New Facilities at the Savannah River Site*, rev. 1, UCRL-ID-128271, Lawrence Livermore National Laboratory, Livermore, CA, September.

UC (Regents of the University of California), 1999d, *Fissile Materials Disposition Program, EIS Data Call Report: Plutonium Immobilization Plant Using Ceramic in New Facilities at the Savannah River Site*, rev. 1, UCRL-ID-128273, Lawrence Livermore National Laboratory, Livermore, CA, September.

Chapter 3
Affected Environment

3.1 APPROACH TO DEFINING THE AFFECTED ENVIRONMENT

In accordance with the Council on Environmental Quality National Environmental Policy Act (NEPA) regulations (CEQ 1986) on preparing an environmental impact statement (EIS), the affected environment is "interpreted comprehensively to include the natural and physical environment and the relationship of people with that environment." 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 implementing the proposed action and alternatives can be identified and evaluated. For this *Surplus Plutonium Disposition Environmental Impact Statement* (SPD EIS), the baseline conditions are the existing conditions.

Selected Characteristics of the Candidate Sites for the Proposed Surplus Plutonium Disposition Facilities

		Population			Dose per Year[a]	
Site	Area (km^2)	Health Risk ROI[a]	Socio-economic ROI	Site Work Force	MEI (mrem)	Population (person-rem)
Hanford	1,450	380,000	179,949	12,882	0.0074	0.20
INEEL	2,300	121,500	213,547	8,291	0.031	0.24
Pantex	60	275,000	212,729	2,944	0.000088	0.0021
SRS	800	620,100	453,778	15,032	0.20	8.6

[a] For 1996.

Key: MEI, maximally exposed individual; ROI, region of influence.

The candidate sites for the proposed surplus plutonium disposition facilities are the Hanford Site (Hanford), Idaho National Engineering and Environmental Laboratory (INEEL), the Pantex Plant (Pantex), and the Savannah River Site (SRS). As described in Chapter 2, areas within the boundaries of the sites that are potential locations for the proposed facilities include the 200 East and 400 Areas at Hanford, the Idaho Nuclear Technology and Engineering Center (INTEC)[1] at INEEL, Zone 4 West at Pantex, and F- and S-Areas at SRS. The resources that are described for the candidate sites are air quality and noise, waste management, socioeconomics, human health risk, environmental justice, geology and soils, water resources, ecological resources, cultural and paleontological resources, land use and visual resources, and infrastructure.

Candidate sites for mixed oxide (MOX) fuel lead assembly fabrication and postirradiation examination are described in Section 3.6. These sites are Hanford, INEEL (at Argonne National Laboratory–West [ANL–W]), Lawrence Livermore National Laboratory (LLNL), Los Alamos National Laboratory (LANL), Oak Ridge Reservation (ORR) (at Oak Ridge National Laboratory [ORNL]), and SRS. These additional sites are evaluated for related plutonium disposition activities only; therefore, they are not described in detail. Sites that would supply uranium dioxide are not described in this section because these activities are routinely performed at these locations, would be conducted in existing buildings with existing personnel, and would not be expected to result in additional impacts at these sites. See Figure 2–1 for the location of these sites.

Proposed reactor sites where the irradiation of MOX fuel would be performed are described in Section 3.7. The reactors that would be used are Catawba Nuclear Station Units 1 and 2, McGuire Nuclear Station Units 1 and 2, and North Anna Power Station Units 1 and 2. As described in Section 2.4.3, these reactors would be used for the irradiation of MOX fuel only.

[1] Formerly known as the Idaho Chemical Processing Plant (ICPP).

The U.S. Department of Energy (DOE) evaluated the environmental impacts of the surplus plutonium disposition alternatives within defined regions of influence (ROI) at each of the four candidate sites and along transportation routes. The ROIs are specific to the type of effect evaluated and encompass geographic areas within which any significant impact would be expected to occur. For example, human health risks to the general public from exposure to airborne contaminant emissions were assessed for an area within an 80 km (50 mi) radius of the proposed facilities. The human health risks of shipping materials among sites were evaluated for populations living along the roadways linking the DOE sites. Economic effects such as job and income growth were evaluated within a socioeconomic ROI that includes the county in which the site is located and nearby counties in which a substantial portion of the site's workforce resides. Brief descriptions of the ROIs are given in Table 3–1. More detailed descriptions of the ROI and the methods used to evaluate impacts are presented in Appendix F.

Table 3–1. General Regions of Influence for the Affected Environment

Environmental Feature	Region of Influence
Air quality and noise	The site and nearby offsite areas within local air quality control regions and the transportation corridors between the sites
Waste management	Waste management facilities on the site
Socioeconomics	The counties where at least 90 percent of site employees reside
Human health risk	The site and nearby offsite areas (within 80 km of the site and the transportation corridors between the sites) where worker and general population radiation, radionuclide, and hazardous chemical exposures may occur
Environmental justice	The minority and low-income populations within 80 km of the site and along the transportation corridors between the sites
Geology and soils	Geologic and soil resources within the site and nearby offsite areas
Water resources	Onsite and adjacent surface water bodies and groundwater
Ecological resources	The site and adjacent areas where ecological communities exist including nonsensitive and sensitive habitats and species
Cultural and paleontological resources	The area within the site and adjacent to the site boundary
Land use and visual resources	The site and the areas immediately adjacent to the site
Infrastructure	Power, fuel supply, water supply, and road systems on the site

At each of the four candidate sites, baseline conditions for each environmental resource area were determined from information provided in previous environmental studies, relevant laws and regulations, and other government reports and databases. More detailed information on the affected environment at the candidate sites can be found in annual site environmental reports and site NEPA documents.

For More Detailed Information on Environmental Conditions at the Candidate Sites for the Proposed Surplus Plutonium Disposition Facilities[a]

Draft Hanford Remedial Action EIS and Comprehensive Land Use Plan, 1996

DOE Programmatic Spent Nuclear Fuel Management and INEL Environmental Restoration and Waste Management Final EIS, 1995

Final EIS for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components, 1996

SRS Waste Management Final EIS, 1995

[a] Also consult annual site environmental reports.

3.2 HANFORD

Hanford, established in 1943 as one of the three original Manhattan Project sites, is in Washington State just north of Richland (Figure 2–2). 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, research and development (R&D) for advanced reactors, renewable energy technologies, waste disposal technologies and contamination cleanup, and plutonium stabilization and storage (DOE 1996a:3-20).

Hanford is owned and used primarily by DOE, but 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, State Routes 24 and 240, and the Columbia River. By restricting access to the site, the public is buffered from the 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 vacant land with widely scattered facilities. The entire Hanford Site has been designated a National Environmental Research Park (DOE 1996a:3-20).

Hanford includes extensive production, service, and R&D areas. Onsite programmatic and general purpose facilities total approximately 799,000 m^2 (8.6 million ft^2) of space. Fifty-one percent (408,000 m^2 [4.4 million ft^2]) is general purpose space, including offices, laboratories, shops, warehouses, and other support facilities. The remaining 392,000 m^2 (4.2 million 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. The existing facilities are grouped into the following numbered operational areas (DOE 1996a:3-20, 3-21).

- The 100 Areas, in the northern part of the site on the southern shore of the Columbia River, are the site of eight retired plutonium 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 in the center of the site and are about 8 and 11 km (5 and 6.8 mi), respectively, south of the Columbia River. Historically, these areas have been used for fuel reprocessing; plutonium processing, fabrication, and storage; and waste management and disposal activities. The 200 Areas cover about 1,600 ha (3,950 acres).

- The 300 Area is in the southern part of the site, just north of the city of Richland. A few of the facilities continue to support nuclear and nonnuclear R&D to include the Pacific Northwest National Laboratory (PNNL). Many of the facilities in the 300 Area are in the process of being deactivated. This area covers 150 ha (370 acres).

- The 400 Area, about 8 km (5 mi) northwest of the 300 Area, is the location of the recently shut down Fast Flux Test Facility (FFTF) and Fuels and Materials Examination Facility (FMEF). FFTF is an advanced liquid-metal-cooled research reactor that was used in the testing of breeder reactor systems. The six-level process building (427 Building) is the main structure of FMEF and encloses about 17,000 m^2 (183,000 ft^2) of operating area. FMEF also consists of several connected buildings. 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 support facilities and infrastructure (e.g., roads, railroads, telecommunications, water treatment and distribution, electrical transmission lines and substations, fire and ambulance, access control facilities, borrow pits, and a landfill).

- The 700 Area is the administrative center in downtown Richland and consists of government-owned buildings (e.g., the Federal Building).

- The 3000 Area is a support area in north Richland that is being vacated but still contains some administrative and support facilities.

In addition, there are DOE-leased facilities and DOE contractor-owned facilities that support Hanford operations. These facilities are on private land south of the 300 Area and outside of the 3000 Area (DOE 1996a:3-21).

DOE Activities. The Hanford mission is to clean up the site, provide scientific and technological excellence to meet global needs, and partner the economic diversification of the region. Current DOE activities that support Hanford's mission are shown in Table 3–2. 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. In addition, as part of the cleanup mission, DOE has the responsibility to safely store, handle, and stabilize plutonium materials and spent fuel (DOE 1996a:3-21, 3-22).

Table 3–2. Current Missions at Hanford

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 R&D, 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

Source: DOE 1996a:3-22.

Non-DOE Activities. In addition to the DOE mission-related activities, Hanford has some unique and diverse assets and non-DOE missions that include the following (DOE 1996a:3-22):

- The Fitzner-Eberhardt Arid Lands Ecology Reserve, 31,100 ha (76,800 acres), established in 1967, managed by the U.S. Fish and Wildlife Service (USFWS) for DOE as a habitat and wildlife reserve and nature research center (Sandberg 1998a).

- The area north of the Columbia River, managed in part by the Washington State Department of Wildlife as the Wahluke Slope Wildlife Recreation Area and in part by the USFWS as the Saddle Mountain National Wildlife Refuge.

- The Washington Nuclear Plant–2 (WNP–2), 1,100-MWe reactor operated by Energy Northwest (formerly Washington Public Power Supply System [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.

- The Hanford Meteorological Station and towers.

- An observatory and radio telescope facilities on Rattlesnake Mountain.

- The U.S. Ecology commercial low-level radioactive waste disposal site on State-leased lands south of the 200 Areas near the center of Hanford.

3.2.1 Air Quality and Noise

3.2.1.1 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. Air pollutants are transported, dispersed, or concentrated by meteorological and topographical conditions. Air quality is affected by air pollutant emission characteristics, meteorology, and topography.

3.2.1.1.1 General Site Description

The climate at Hanford and the surrounding region is characterized as that of a semiarid steppe. The humidity is low, and winters are mild. The average annual temperature is 11.8 EC (53.3 EF); average monthly temperatures range from a minimum of -1.5 EC (29.3 EF) in January to a maximum of 24.7 EC (76.5 EF) in July. The average annual precipitation is 16 cm (6.3 in). Prevailing winds at the Hanford Meteorological Station are from the west-northwest. The average annual windspeed is 3.4 m/s (7.6 mph) (DOE 1996a:3-29). Additional information related to meteorology and climatology at Hanford is presented in Appendix F of the *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement (Storage and Disposition PEIS)* (DOE 1996a:F-2–F-5) and in the *Hanford Site National Environmental Policy Act (NEPA) Characterization* (Neitzel 1996).

Most of Hanford is within the South-Central Washington Intrastate Air Quality Control Region (AQCR) #230, but a small portion of the site is in the Eastern Washington-Northern Idaho Interstate AQCR #62. None of the areas within Hanford and its surrounding counties are designated as nonattainment areas with respect to National Ambient Air Quality Standards (NAAQS) for criteria air pollutants (EPA 1997a). Applicable NAAQS and Washington State ambient air quality standards are presented in Table 3–3.

There are no prevention of significant deterioration (PSD) Class I areas within 100 km (62 mi) of Hanford. Hanford operates under a PSD permit issued in 1980 that limits emissions of nitrogen dioxide from the Plutonium-Uranium Extraction (PUREX) and Uranium Trioxide Plants in the 200 Area (DOE 1996a:3-29). These facilities have not been operated since 1994 and have been deactivated and transferred to the

Table 3–3. Comparison of Ambient Air Concentrations From Hanford Sources With Most Stringent Applicable Standards or Guidelines, 1994

Pollutant	Averaging Period	Most Stringent Standard or Guideline (Fg/m³)[a]	Concentration (Fg/m³)
Criteria pollutants			
Carbon monoxide	8 hours	10,000[b]	0.7
	1 hour	40,000[b]	2.6
Nitrogen dioxide	Annual	100[b]	0.2
Ozone	8 hours	157[c]	(d)
PM_{10}	Annual	50[b]	0.01
	24 hours	150[b]	0.1
$PM_{2.5}$	3-year annual	15[c]	(e)
	24 hours (98th percentile over 3 years)	65[c]	(e)
Sulfur dioxide	Annual	50[f]	0.8
	24 hours	260[f]	6.6
	3 hours	1,300[b]	22.9
	1 hour	1,000[f]	47.9
	1 hour	660[f,g]	47.9
Other regulated pollutants			
Gaseous fluoride	30 days	0.84[f]	(i)
	7 days	1.7[f]	(i)
	24 hours	2.9[f]	(i)
	12 hours	3.7[f]	(i)
	8 months (Mar-Oct)	0.50[f]	(i)
Total suspended particulates	Annual	60[f]	0.01
	24 hours	150[f]	0.1
Hazardous and other toxic compounds			
Benzene	24 hours	0.12[h]	(i)
[Text deleted.]			

[a] The more stringent of the Federal and State standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (NAAQS) (EPA 1997a), other than those for ozone, particulate matter, and lead, and those based on annual averages, are not to be exceeded more than once per year. The 1-hr ozone standard is attained when the expected number of days per year with maximum hourly average concentrations above the standard is #1. The 1-hr ozone standard applies only to nonattainment areas. The 8-hr ozone standard is attained when the 3-year average of the annual fourth-highest daily maximum 8-hr average concentration is less than or equal to 157 Fg/m³. The 24-hr particulate matter standard is attained when the expected number of days with a 24-hr average concentration above the standard is #1. The annual arithmetic mean particulate matter standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard.

[b] Federal and State standard.

[c] Federal standard.

[d] Not directly emitted or monitored by the site.

[e] No data is available with which to assess $PM_{2.5}$ concentrations.

[f] State standard.

[g] Not to be exceeded more than twice in any 7 consecutive days.

[h] State's risk-based acceptable source impact levels.

[i] No sources identified at the site.

Note: NAAQS also include standards for lead. No sources of lead emissions have been identified at the site. Emissions of other air pollutants not listed here have been identified at Hanford, but are not associated with any alternatives evaluated. These other air pollutants are quantified in the *Storage and Disposition PEIS* (DOE 1996a). EPA recently revised

ambient air quality standards for particulate matter and ozone. The new standards, finalized on July 18, 1997, changed the ozone primary and secondary standards from a 1-hr concentration of 235 Fg/m^3 (0.12 ppm) to an 8-hr concentration of 157 Fg/m^3 (0.08 ppm). During a transition period while States are developing State implementation plan revisions for attaining and maintaining these standards, the 1-hr ozone standard will continue to apply in nonattainment areas (EPA 1997b:38855). For particulate matter, the current PM_{10} annual standard is retained, and two $PM_{2.5}$ (particulate matter with an aerodynamic diameter less than or equal to 2.5 Fm) standards are added. These standards are set at a 15-Fg/m^3 3-year annual arithmetic mean based on community-oriented monitors and a 65-Fg/m^3 3-year average of the 98th percentile of 24-hr concentrations at population-oriented monitors. The revised 24-hr PM_{10} standard is based on the 99th percentile of 24-hr concentrations. The existing PM_{10} standards will continue to apply in the interim period (EPA 1997c:38652).
Source: DOE 1996a:3-30; EPA 1997a; WDEC 1994.

DOE Office of Environmental Restoration for continued surveillance and maintenance awaiting eventual decommissioning.

Ambient air quality near the Hanford boundary is currently monitored for particulate matter. Particulate concentrations can reach rather high levels in eastern Washington because of extreme natural events (dust storms, volcanic eruptions, and large brush fires [DOE 1996b:4-46–4-50]). The 24-hr standard for particulate matter with an aerodynamic diameter less than or equal to 10 Fm (PM_{10}) was exceeded in 1993 at Columbia Center in Kennewick, about 10 km (6.2 mi) southeast of Hanford, likely as a result of windblown dust. Ambient air quality at Hanford is discussed in more detail in the *Hanford Site 1995 Environmental Report* (Dirkes and Hanf 1996:56, 61, 62, 95–108). Routine monitoring of most nonradiological pollutants is not conducted at the site. Monitoring of nitrogen oxides and total suspended particulates at Hanford has been discontinued as a result of phasing out programs for which the monitoring was required. Carbon monoxide, sulfur dioxide, and nitrogen dioxide have been monitored periodically in communities and commercial areas southeast of Hanford. In 1995, air samples of semivolatile organic compounds were collected on the site and at an offsite location, and the results are discussed in the annual environmental report (Dirkes and Hanf 1996:95–108). All concentrations of these compounds were below the applicable risk-based concentrations.

The primary sources of air pollutants at Hanford include process emissions, vehicular emissions, and construction activities. Table 3–3 presents the existing ambient air pollutant concentrations at the site boundary attributable to sources at Hanford. These concentrations are based on emissions for the year 1994. The emissions were modeled using meteorological data from 1989–1990 (DOE 1996a:3-30). Only those pollutants that would be emitted by any of the surplus plutonium disposition alternatives are presented. With the exception of particulate matter, as discussed previously, the concentrations of these pollutants—concentrations from Hanford combined with those from background (non-Hanford) sources—are in compliance with the ambient air quality standards. All coal-fired steam generation facilities have been shut down at Hanford. The conversion to oil, natural gas, and electric energy sources was completed in 1998. This will result in a significant reduction in air pollutant emissions from the site. Detailed information on emissions of other pollutants at Hanford is discussed in the *Hanford Site NEPA Characterization* (Neitzel 1996:4.28–4.32, 6.12).

3.2.1.1.2 Proposed Facility Locations

Prevailing winds in the 200 Areas (Hanford Meteorological Station) are from the west-northwest (Neitzel 1996:4.3, 4.6; Hoitink and Burk 1996:2.10). The 200 East Area has emissions of various air pollutants from oil-fired steam generation and releases of various toxic pollutants from tank farms, waste processing, and laboratories. Emissions from these sources are quantified in the *Tank Waste Remediation System EIS* (DOE 1996c:G-35–G-111).

Prevailing winds in the 400 Area are from the south-southwest, with a secondary maximum from the northwest (Neitzel 1996:4.6; Hoitink and Burk 1996:2.10). The 400 Area has no nonradioactive air pollutant emission sources of concern (Neitzel 1996:4.30).

3.2.1.2 Noise

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.

3.2.1.2.1 General Site Description

Major noise sources within Hanford include various facilities, equipment, and machines (e.g., 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 the 24-hr equivalent sound level) at Hanford range from 30 to 60.5 decibels A-weighted (dBA) (DOE 1996a:3-29). The 24-hr background sound level in undeveloped areas at Hanford ranges from 24 to 36 dBA, except when high winds elevate sound levels (Neitzel 1996:4.127). The primary source of noise at the site and nearby residences is traffic. Most Hanford industrial facilities are far enough from the site boundary that noise levels from these sources at the boundary are not measurable or are barely distinguishable from background noise levels (DOE 1996a:3-29). Hanford is currently in compliance with the State noise regulations (DOE 1996a:3-29–3-31). Noise sources, existing noise levels at Hanford, and noise standards are described in the *Storage and Disposition PEIS* (DOE 1996a:3-29–3-31, F-31, F-32) and in the *Hanford Site NEPA Characterization* (Neitzel 1996:4.125–4.130).

The potential impact of traffic noise resulting from Hanford activities was evaluated for a draft EIS addressing the siting of the proposed New Production Reactor. Estimates were made of baseline traffic noise along two major access routes: State Route 24, leading from the Hanford Site west to Yakima, and State Route 240, south of the site and west of Richland, where it handles maximum traffic volume. Modeled traffic noise levels (equivalent sound level [1-hr]) at 15 m (50 ft) from State Route 24 for both peak and offpeak periods were 62 dBA. Traffic noise levels from State Route 240 for both peak and offpeak periods were 70 dBA (Neitzel 1996:4.127, 4.130). These traffic noise levels were projections based on employment levels about 30 percent higher than actual levels at Hanford in 1997. About 9 percent of Hanford's employees commute by vanpool or bus (Mecca 1997a). Existing traffic noise levels may be different as a result of changes in site employment and ride-sharing activities.

The U.S. Environmental Protection Agency (EPA) guidelines for environmental noise protection recommend an average day-night average sound level of 55 dBA as sufficient to protect the public from the effects of broadband environmental noise in typically quiet outdoor and residential areas (EPA 1974:29). Land-use compatibility guidelines adopted by the Federal Aviation Administration and the Federal Interagency Committee on Urban Noise indicate that yearly day-night average sound levels less than 65 dBA are compatible with residential land uses and levels up to 75 dBA are compatible with residential uses if suitable noise reduction features are incorporated into structures (DOT 1995). It is expected that for most residences near Hanford, the day-night average sound level is less than 65 dBA and is compatible with the residential land use, although for some residences along major roadways noise levels may be higher.

3.2.1.2.2 Proposed Facility Locations

No distinguishing noise characteristics have been identified at either the 200 East Area or the 400 Area. Both are far enough from the site boundary—the 200 East Area is 12.6 km (7.8 mi) and the 400 Area is 6.1 km (3.8 mi)

away—that noise levels from the facilities at the boundary are not measurable or are barely distinguishable from background levels.

3.2.2 Waste Management

Waste management includes minimization, characterization, treatment, storage, transportation, and disposal of waste generated from ongoing DOE 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.

3.2.2.1 Waste Inventories and Activities

Hanford manages the following types of waste: high-level waste (HLW), transuranic (TRU), mixed TRU, low-level waste (LLW), mixed LLW, hazardous, and nonhazardous. HLW would not be generated by surplus plutonium disposition activities at Hanford, and thus is not discussed further. Waste generation rates and the inventory of stored waste from activities at Hanford are provided in Table 3–4. Table 3–5 summarizes the Hanford waste management capabilities. More detailed descriptions of the waste management system capabilities at Hanford are included in the *Storage and Disposition PEIS* (DOE 1996a:3-61, E-12).

Table 3–4. Waste Generation Rates and Inventories at Hanford

Waste Type	Generation Rate (m^3/yr)	Inventory (m^3)
TRU[a]		
Contact handled	450	11,450
Remotely handled	72	273
LLW	3,902	0
Mixed LLW		
RCRA	840	8,170
TSCA	7	103
Hazardous	560	NA[b]
Nonhazardous		
Liquid	200,000	NA[b]
Solid	43,000	NA[b]

[a] Includes mixed TRU waste.

[b] Generally, hazardous and nonhazardous wastes are not held in long-term storage.

Key: LLW, low-level waste; NA, not applicable; RCRA, Resource Conservation and Recovery Act; TRU, transuranic; TSCA, Toxic Substances Control Act.

Source: DOE 1996d:15, 16, except hazardous and nonhazardous solid wastes (DOE 1996a:3-62, E-19), and nonhazardous liquid wastes (Teal 1997).

EPA placed Hanford on the National Priorities List on November 3, 1989. In accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), DOE entered into a Tri-Party Agreement with EPA and the State of Washington to govern the environmental compliance and cleanup of Hanford. That agreement meets the legal requirements specified under the Federal Facility Compliance Agreement (FFCA). An aggressive environmental restoration program is under way using priorities established in the Tri-Party Agreement (DOE 1996a:3-61). More information on regulatory requirements for waste disposal is provided in Chapter 5.

3.2.2.2 Transuranic and Mixed Transuranic Waste

All currently generated contact-handled TRU waste is being placed in above-grade storage buildings at the Hanford Central Waste Complex and the TRU Waste Storage and Assay Facility (DOE 1996a:3-64). TRU waste will be maintained in storage until shipped to the Waste Isolation Pilot Plant (WIPP) in Carlsbad, New Mexico, for disposal, beginning in 2000 (Aragon 1999). The new Waste Receiving and Processing Facility has the capability to process retrieved suspect TRU waste and certify newly generated and stored TRU waste for shipment to WIPP (Dirkes and Hanf 1996:10). Treatment of TRU waste will be provided in the future at the Stabilization Facility and Thermal Treatment Facility. TRU waste will be treated to meet WIPP waste acceptance criteria, packaged in accordance with DOE and U.S. Department of Transportation (DOT) requirements, and transported to WIPP for disposal (DOE 1996a:3-144). Mixed TRU

Table 3–5. Waste Management Capabilities at Hanford

Facility Name/Description	Capacity	Status	Applicable Waste Type: TRU	Mixed TRU	LLW	Mixed LLW	Haz	Non-Haz
Treatment Facility (m^3/yr except as otherwise specified)								
242-A Evaporator, m^3/day	265	Online	X	X	X	X		
Waste Receiving and Processing Facility	1,820	Online	X	X	X	X		
Stabilization Facility Contract	1,860	Planned for 1999	X	X		X		
Thermal Treatment Facility Contract	5,135	Planned for 2001	X	X		X		
Grout Treatment Facility	15,000	Online				X		
Shielded Analytical Lab Waste Treatment Unit, kg/hr	4	Online				X		
Maintenance & Storage Facility, batch/yr	26	Online				X		
200 Area Effluent Treatment Facility, m^3/min	0.57	Online			X	X		
200 East Area Sanitary Wastewater Treatment Facility	120,000	Online						X
Storage Facility (m^3)								
Central Waste Complex	16,800	Online	X	X	X	X		
TRU Waste Storage and Assay Facility	416	Standby	X	X	X	X		
305-B Storage Facility	20	Online			X	X	X	
B-Plant Canyon Waste Pile	5	Online			X			
B-Plant Container Storage	51	Online				X		
PUREX Tunnel 1	4,141	Online			X	X		
PUREX Tunnel 2	19,528	Online			X	X		
PUREX Canyon Waste Pile	432	Online				X		
200 Area Liquid Effluent Retention Facility	59,000	Online			X	X		
4843 Alkali Metal Storage Facility	95	Standby				X	X	
Disposal Facility (m^3 except as otherwise specified)								
Grout Vaults	230,000	Online			X			
LLW Burial Ground	1,740,000	Online			X			
Radioactive Mixed Waste Disposal Facility	14,200	Standby			X	X		
200 Area Treated Effluent Disposal Facility, m^3/min	8.7	Online						X
Energy Northwest Sewage Treatment Facility, m^3/yr	235,000	Online						X

Key: Haz, hazardous; LLW, low-level waste; PUREX, Plutonium-Uranium Extraction (Plant); TRU, transuranic.
Source: Dirkes and Hanf 1996:46; Kovacs 1997; Rhoderick 1998; Sandberg 1998a; Teal 1997.

wastes are included in the TRU waste category because these wastes are expected to go to WIPP for ultimate disposal (DOE 1996a:3-64).

3.2.2.3 Low-Level Waste

Solid LLW is compacted and sent to the LLW Burial Ground in the 200 West Area for disposal in trenches. Additional LLW is received from offsite generators and disposed of at the LLW Burial Ground. LLW resulting from the tank waste remediation system waste pretreatment program will be vitrified; as a contingency, the Grout Facility will be maintained in standby condition. The vitrified LLW will be disposed of on the site in the 200 Area under the tank waste remediation system program (DOE 1996a:3-64).

U.S. Ecology operates a licensed commercial LLW Burial Ground on a site southwest of the 200 East Area that is leased to the State of Washington. The facility is not a DOE facility and is not considered part of DOE's Hanford operations (DOE 1996a:E-17).

3.2.2.4 Mixed Low-Level Waste

One of the existing treatment facilities for mixed LLW is the 242-A Evaporator in the 200 East Area, which reduces the volume of these wastes and removes cesium via ion exchange (DOE 1996a:3-64). The process condensate from the evaporator is temporarily stored in the Liquid Effluent Retention Facility until it is treated in the Liquid Effluent Treatment Facility. The Liquid Effluent Retention Facility consists of three Resource Conservation and Recovery Act (RCRA)–compliant surface impoundments for storing process condensate from the 242-A Evaporator. This facility provides equalization of the flow and pH to the Liquid Effluent Treatment Facility. The Liquid Effluent Treatment Facility provides ultraviolet light/peroxide destruction of organic compounds, reverse osmosis to remove dissolved solids, and ion exchange to remove the last traces of contaminants. Discharge of the treated effluent is via a dedicated pipeline to an underground drain field. The effluent treatment process produces a mixed LLW sludge that is concentrated, dried, packaged in 208-l (55-gal) drums, and transferred to the Central Waste Complex. This secondary waste is stored prior to treatment (if necessary) and disposal in the Mixed Waste Trench (Dirkes and Hanf 1996:10, 45, 46). In a recent modification to the Tri-Party Agreement, DOE has agreed to begin designing a vitrification facility to treat liquid mixed LLW (DOE 1996a:E-17; E-18).

The Waste Receiving and Processing Facility, near the Central Waste Complex in the 200 West Area, eventually will provide size reduction, decontamination, condensation, melting, amalgamation, incineration, ash stabilization, and shipping for Hanford mixed waste. The Waste Receiving and Processing Facility is being constructed in two phases: module 1 and module 2 (2A and 2B) and is designed to process 6,800 drums of waste annually (Dirkes and Hanf 1996:40). Module 1 will be designed to prepare retrieved and stored TRU waste and will be operational in 1999. Module 2A is designed to process LLW, TRU waste, mixed LLW, and mixed TRU waste, and is operational. Module 2B, if authorized, will be designed to process LLW, TRU waste, mixed LLW, and mixed TRU waste with a dose rate greater than 200 mrem/hr. Module 2B has an undetermined startup date (DOE 1996a:E-18).

The Radioactive Mixed Waste Disposal Facilities are in the Hanford LLW Burial Ground and are designated as 218-W-5, Trench 31, and Trench 34. The facilities consist of rectangular trenches with approximate dimensions of 76 by 30 m (250 by 100 ft). These facilities are RCRA compliant, with double liners and leachate collection and removal systems (Dirkes and Hanf 1996:40).

3.2.2.5 Hazardous Waste

There are no treatment facilities for hazardous waste at Hanford; therefore, the wastes are accumulated in satellite storage areas (for less than 90 days) or at interim RCRA-permitted facilities such as the 305-B Waste Storage Facility. The common practice for newly generated hazardous waste is to ship it off the site by truck using

DOT-approved transporters for treatment, recycling, recovery, and disposal at RCRA-permitted facilities (DOE 1996a:3-65, E-18; Sandberg 1998a).

3.2.2.6 Nonhazardous Waste

Sanitary wastewater is discharged to onsite treatment facilities such as septic tanks, subsurface soil adsorption systems, and wastewater treatment plants. These facilities treat an average of 600,000 l/day (159,000 gal/day) of sewage (DOE 1996a:E-19).

The 200 Area Treated Effluent Disposal Facility industrial sewer collects the treated wastewater streams from various plants in the 200 Areas and disposes of the clean effluent at two 2-ha (5-acre) ponds permitted by the State of Washington (DOE 1996a:E-19). The design capacity of the facility is approximately 8,700 l/min (2,300 gal/min), although the discharge permit presently limits the average monthly flow to about 2,400 l/min (640 gal/min) (Dirkes and Hanf 1996:46).

Nonhazardous solid wastes include construction debris, office trash, cafeteria wastes, furniture and appliances, nonradioactive friable asbestos, powerhouse ash, and nonradioactive/nonhazardous demolition debris. Until 1997, nonhazardous solid wastes were disposed of in the 600 Area central landfill. Under an agreement between DOE and the city of Richland, most of the site's nonregulated and nonradioactive solid wastes are now sent to the Richland Sanitary Landfill for disposal (DOE 1996a:3-65, E-19). The Richland Sanitary Landfill is at the southern edge of the Hanford Site boundary. Nonradioactive friable asbestos and medical waste are shipped off the site for disposal (Dirkes and Hanf 1996:83; Sandberg 1998a).

3.2.2.7 Waste Minimization

The Hanford Site Pollution Prevention Program is a comprehensive and continual effort to systematically reduce the quantity and toxicity of hazardous, radioactive, mixed, and sanitary wastes; conserve resources and energy; reduce hazardous substance use; and prevent or minimize pollutant releases to all environmental media from all operations and site cleanup activities. In accordance with sound environmental management, preventing pollution through source reduction is the first priority in the Hanford Site Pollution Prevention Program, and the second priority is environmentally safe recycling. For instance, Hanford pollution prevention efforts in 1995 helped to prevent the generation of approximately 2,900 m^3 (3,790 yd^3) of radioactive mixed waste, 207 t (228 tons) of RCRA waste, 30,000 m^3 (39,200 yd^3) of process wastewater, and 4,400 t (4,850 tons) of sanitary waste. Also during 1995, Hanford recycled approximately 632 t (697 tons) of office paper, 20 t (22 tons) of cardboard, 3,600 t (3,970 tons) of ferrous metal, 215 t (237 tons) of nonferrous metal, 57 t (63 tons) of lead, 16 t (18 tons) of solid chemicals, and 78,000 l (20,600 gal) of liquid chemicals. In addition, Hanford's new centralized recycling center collects aerosol cans, fluorescent light ballasts, fluorescent light tubes, and lead acid batteries (Dirkes and Hanf 1996:44, 45).

3.2.2.8 Preferred Alternatives From the WM PEIS

Preferred alternatives from the *Waste Management Programmatic Environmental Impact Statement* (WM PEIS) (DOE 1997a:summary, 95) are shown in Table 3–6 for the four waste types analyzed in this SPD EIS. A decision on the future management of these wastes could result in the construction of new waste management facilities at Hanford and the closure of other facilities. Decisions on the various waste types are expected to be announced in a series of records of decision (RODs) to be issued on this WM PEIS. In fact, the TRU waste ROD was issued on January 20, 1998 (DOE 1998a) with the hazardous waste ROD issued on August 5, 1998 (DOE 1998b). The TRU waste ROD states that DOE will develop and operate mobile and fixed facilities to characterize and prepare TRU waste for disposal at WIPP. Each DOE site that has, or will

Table 3–6. Preferred Alternatives From the WM PEIS

Waste Type	Preferred Action
TRU and mixed TRU	DOE prefers onsite treatment and storage of Hanford's TRU waste pending disposal at WIPP.[a]
LLW	DOE prefers to treat Hanford's LLW on the site. Hanford could be selected as one of the regional disposal sites for LLW.
Mixed LLW	DOE prefers regionalized treatment at Hanford. This includes the onsite treatment of Hanford's wastes and could include treatment of some mixed LLW generated at other sites. Hanford could be selected as one of the regional disposal sites for mixed LLW.
Hazardous	DOE prefers to continue to use commercial facilities for hazardous waste treatment.[a]

[a] ROD for TRU waste (DOE 1998a) and ROD for hazardous waste (DOE 1998b) selected the preferred alternatives for these waste types at Hanford.

Key: LLW, low-level waste; ROD, record of decision; TRU, transuranic; WIPP, Waste Isolation Pilot Plant.
Source: DOE 1997a:summary, 95.

generate, TRU waste will, as needed, prepare and store its TRU waste on the site. The hazardous waste ROD states that most DOE sites will continue to use offsite facilities for the treatment and disposal of major portions of the nonwastewater hazardous waste, with ORR and SRS continuing to treat some of their own hazardous waste on the site in existing facilities where this is economically favorable. More detailed information and DOE's alternatives for the future configuration of waste management facilities at Hanford is presented in the WM PEIS and the hazardous waste and TRU waste RODs.

3.2.3 Socioeconomics

Statistics for employment and regional economy are presented for the regional economic area (REA) as defined in Appendix F.9, which encompasses nine counties surrounding Hanford in Washington. Statistics for population, housing, community services, and local transportation are presented for the ROI, a two-county area in which 91 percent of all Hanford employees reside as shown in Table 3–7. In 1997, Hanford employed about 12,882 persons (about 3.7 percent of the REA civilian labor force) (Mecca 1997b).

Table 3–7. Distribution of Employees by Place of Residence in the Hanford Region of Influence, 1997

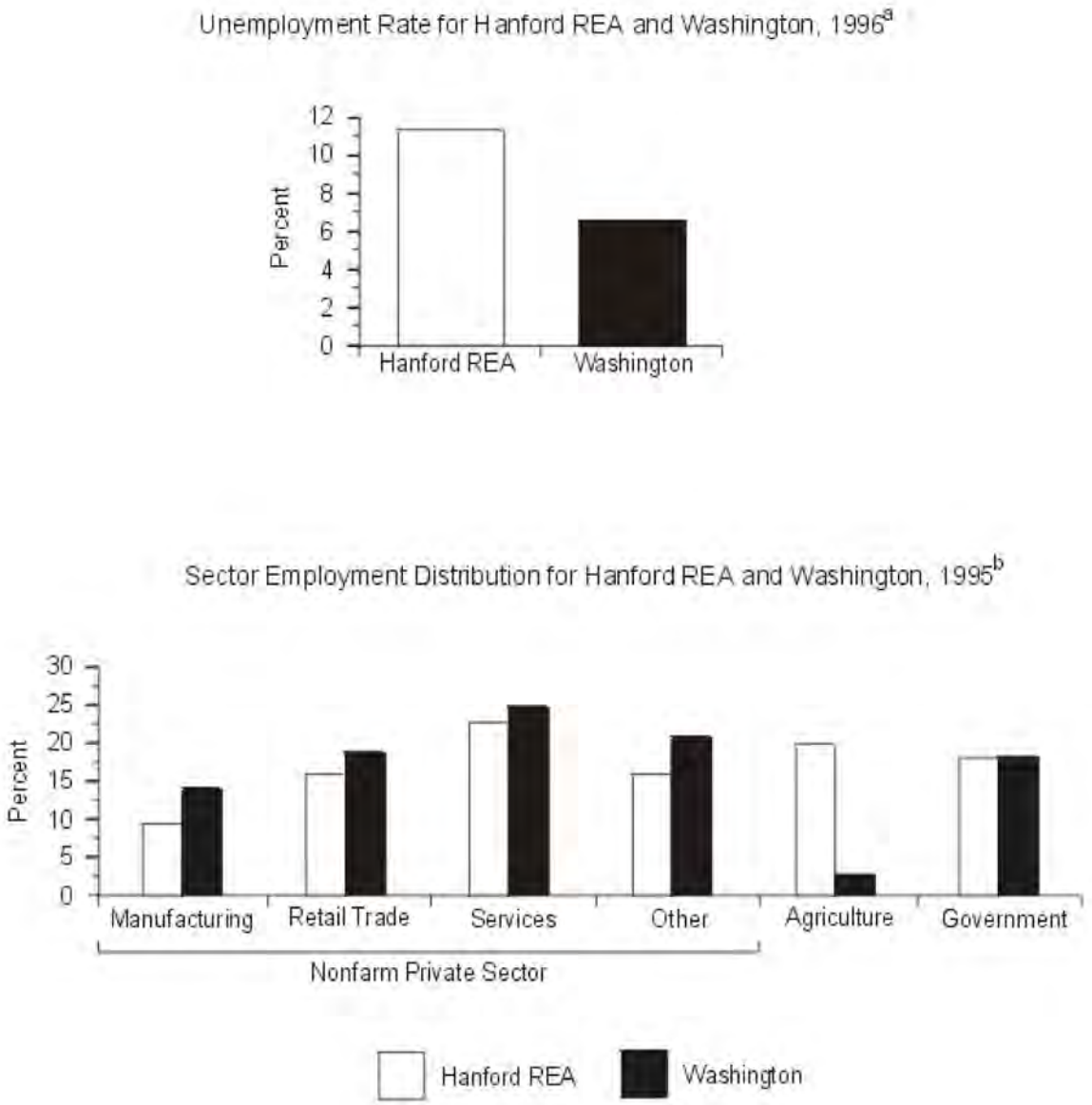
County	Number of Employees	Total Site Employment (Percent)
Benton	10,563	82
Franklin	1,159	9
ROI total	11,722	91

Source: Mecca 1997b.

3.2.3.1 Regional Economic Characteristics

Selected employment and regional economy statistics for the Hanford REA and Washington are summarized in Figure 3–1. Between 1990 and 1996, the civilian labor force in the REA increased 35.3 percent to 344,611. In 1996, the unemployment rate in the REA was 11.1 percent, significantly higher than the rate of 6.5 percent in Washington State (DOL 1999).

In 1995, service activities represented the largest sector of employment in the REA (22.3 percent). This was followed by agriculture (19.6 percent) and government (17.4 percent). Overall, the State total for these employment sectors was 25.0 percent, 3.7 percent, and 18.0 percent, respectively (DOL 1997).



[a] DOL 1999.
[b] DOL 1997.

REA Regional economic area

Figure 3–1. Employment and Local Economy for the Hanford Regional Economic Area and the State of Washington

3.2.3.2 Population and Housing

In 1996, the ROI population totaled 179,949. Between 1990 and 1996, the ROI population increased 18.9 percent compared with the 12.9 percent increase experienced in Washington (DOC 1997). Between 1980 and 1990, the number of housing units in the ROI increased by about 4.6 percent, compared with a 20.3 percent increase in Washington. The total number of housing units within the ROI for 1990 was 58,541 (DOC 1994). The 1990 homeowner vacancy rates for the ROI was 1.4 percent compared with the State's rate of 1.3 percent. The ROI renter vacancy rate was 5.5 percent compared with 5.8 percent for the State (DOC 1990a). Population and housing trends in the ROI and Washington are summarized in Figure 3–2.

3.2.3.3 Community Services

3.2.3.3.1 Education

Ten school districts provide public education in the Hanford ROI. As shown in Figure 3–3, school districts in 1997 were operating at capacities ranging from 65 to 100 percent. In 1997, the student-to-teacher ratio in the ROI averaged 16:1 (Nemeth 1997a). In 1990, the average student-to-teacher ratio for Washington was 11.4:1 (DOC 1990b; 1994).

3.2.3.3.2 Public Safety

In 1997, a total of 281 sworn police officers were serving the ROI. The ROI average officer-to-population ratio was 1.6 officers per 1,000 persons (Nemeth 1997b). This compares with the 1990 State average of 1.7 police officers per 1,000 persons (DOC 1990b). In 1997, 616 paid and volunteer firefighters provided fire protection services in the Hanford ROI. The average firefighter-to-population ratio in 1997 in the ROI was 3.4 firefighters per 1,000 persons (Nemeth 1997b). This compares with the 1990 State average of 1 firefighter per 1,000 persons (DOC 1990b). Figure 3–4 displays the ratio of sworn police officers and firefighters to population for the two counties in the Hanford ROI.

3.2.3.3.3 Health Care

In 1996, a total of 257 physicians served the ROI. The average physician-to-population ratio in the ROI was 1.4 physicians per 1,000 persons compared with the 1996 State average of 3.7 per 1,000 persons (Randolph 1997). In 1997, there were four hospitals serving the ROI. The hospital bed-to-population ratio averaged 2.1 beds per 1,000 persons (Nemeth 1997c). This compares with a State 1991 average of 2.4 beds per 1,000 persons (DOC 1996:128). Figure 3–4 displays the ratio of physicians-to-population and hospital bed-to-population for the two counties in the Hanford ROI.

3.2.3.4 Local Transportation

Vehicular access to Hanford is provided by State Routes 240, 243, 24, and Stevens Drive. State Route 240 connects to the Richland bypass highway, which interconnects with I–182. State Route 243 exits the site's northwestern boundary and serves as a primary link between the site and I–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 about 16 km (10 mi) east of the site boundary. Stevens Drive out of north Richland is the favored route to Hanford (see Figure 2–2).

One current road improvement project that could affect vehicular access to Hanford is repaving and signal work at the intersection of State Route 240 and Stevens Drive. Two projects, currently in the planning stage, could affect vehicular access to Hanford in the future: a realignment of State Route 240 from Stevens Drive

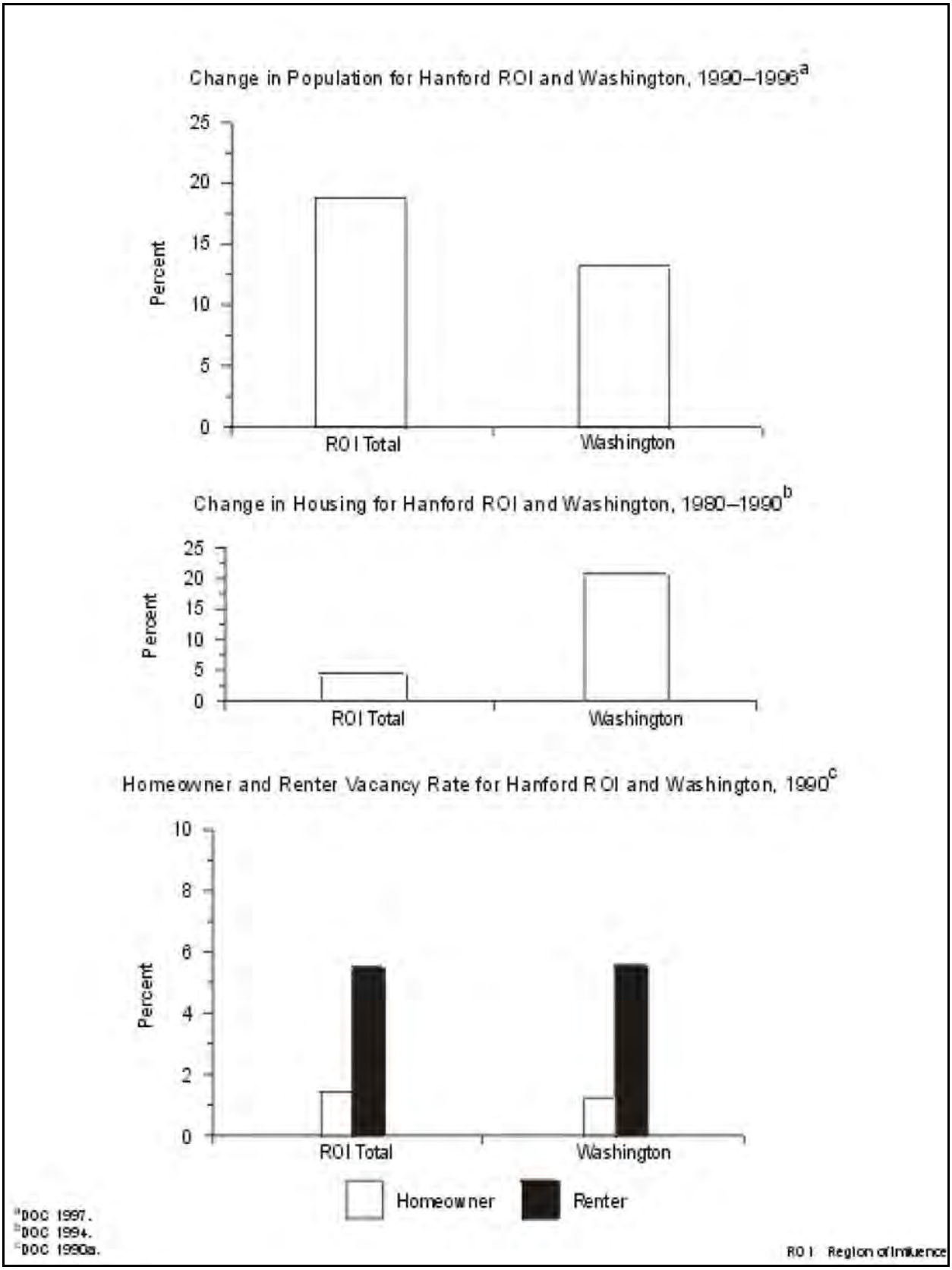


Figure 3–2. Population and Housing for the Hanford Region of Influence and the State of Washington

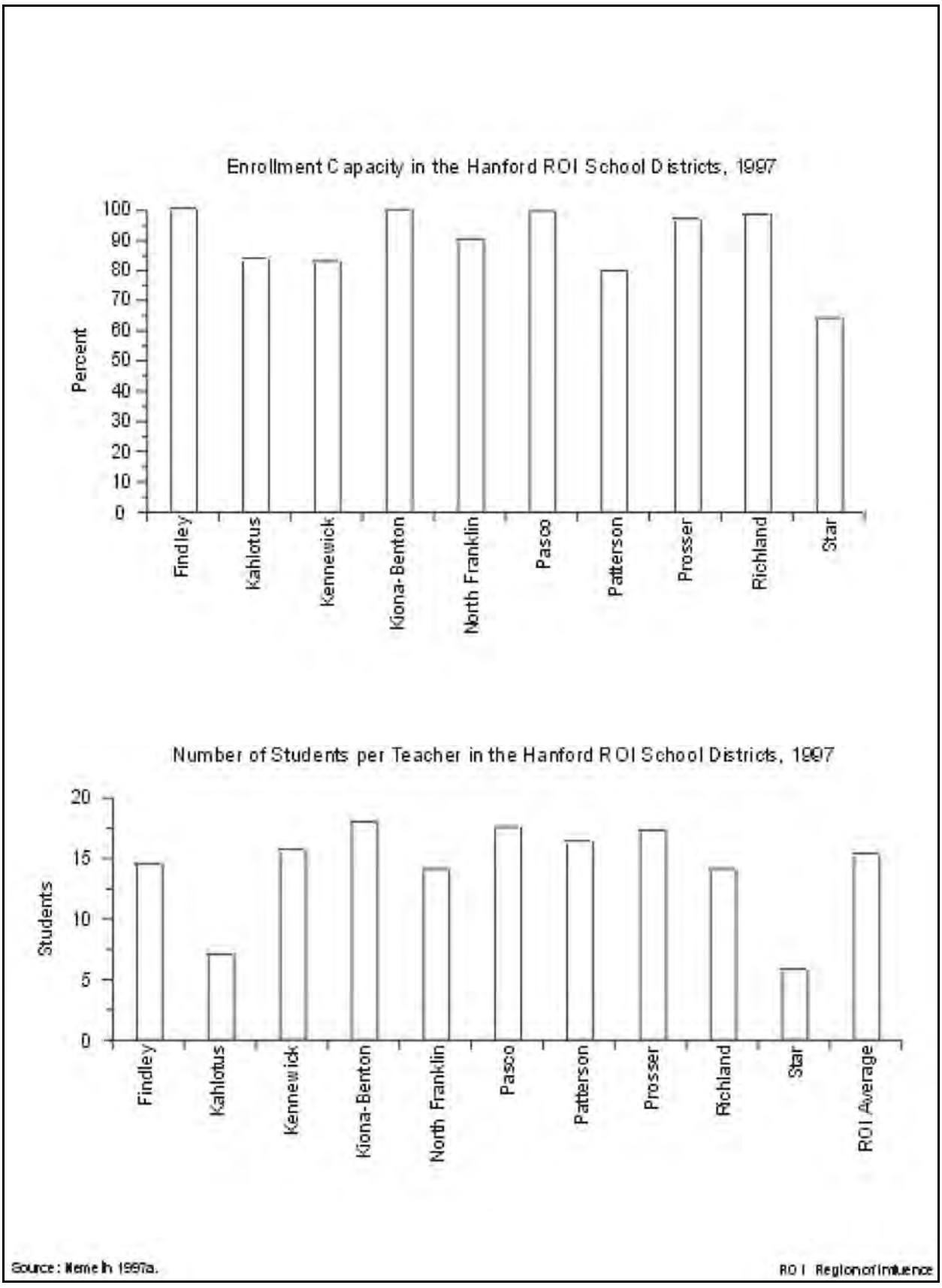


Figure 3–3. School District Characteristics for the Hanford Region of Influence

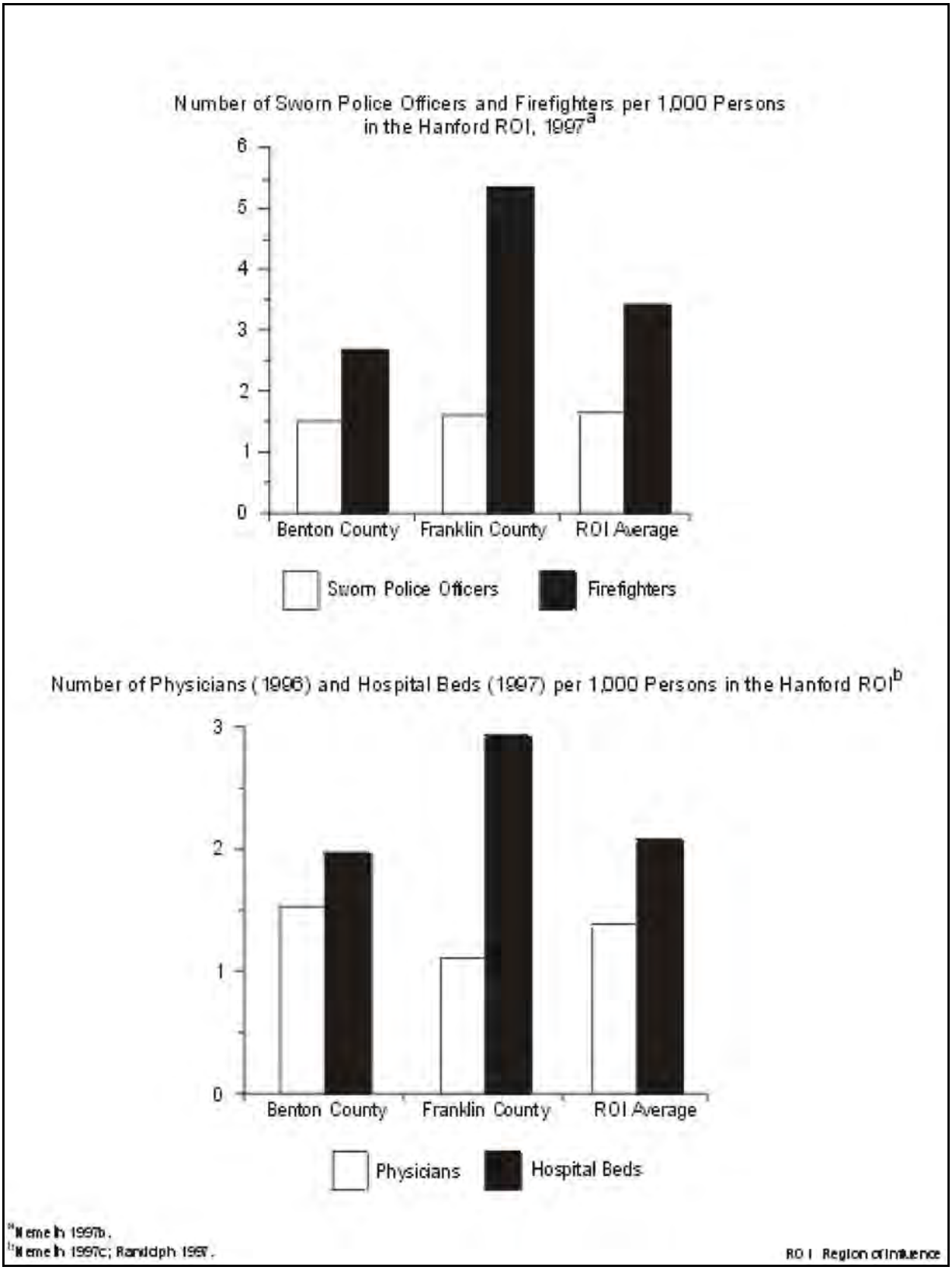


Figure 3–4. Public Safety and Health Care Characteristics for the Hanford Region of Influence

to State Route 224 and the paving of asphalt overlay of State Route 224 from West Richland to State Route 240 in the year 2000 (MacNeil 1997). However, an improvement project on Grosscup Road would provide relief of congestion due to State Route 224 paving activities.

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 vanpooling opportunities in the ROI.

Onsite rail transport is provided by a short-line railroad that 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 the city of Kennewick. There is no passenger rail service at Hanford (see Section 3.2.11.1.1 for more information).

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.

Tri-Cities Airport, 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 (DOE 1996a).

3.2.4 Existing Human Health Risk

Public and occupational health and safety issues include the determination of potentially adverse effects on human health that result from acute and chronic exposures to ionizing radiation and hazardous chemicals.

3.2.4.1 Radiation Exposure and Risk

3.2.4.1.1 General Site Description

Major sources and levels of background radiation exposure to individuals in the vicinity of Hanford are shown in Table 3–8. Annual background radiation doses to individuals are expected to remain constant over time. The total dose to the population, in terms of person-rem, changes as the population size changes. Background radiation doses are unrelated to Hanford operations.

Table 3–8. Sources of Radiation Exposure to Individuals in the Hanford Vicinity Unrelated to Hanford Operations

Source	Effective Dose Equivalent (mrem/yr)
Natural background radiation[a]	
Cosmic radiation	30
External terrestrial radiation	30
Internal terrestrial radiation	40
Radon in homes (inhaled)	200[b]
Other background radiation[c]	
Diagnostic x rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	365

[a] Dirkes and Hanf 1997:264.

[b] An average for the United States.

[c] NCRP 1987:11, 40, 53.

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 1996 are listed in the *Hanford Site Environmental Report for Calendar Year 1996* (Dirkes and Hanf 1997:65–71). Doses to the public resulting from these releases are presented in Table 3–9. These doses fall within radiological limits per DOE Order 5400.5 (DOE 1993a:II-1–II-5) and are much lower than those of background radiation.

Table 3–9. Radiation Doses to the Public From Normal Hanford Operations in 1996 (Total Effective Dose Equivalent)

	Atmospheric Releases[a]		Liquid Releases		Total	
Members of the Public	**Standard[b]**	**Actual**	**Standard[b]**	**Actual**	**Standard[b]**	**Actual**
Maximally exposed individual (mrem)	10	4.6×10^{-3}	4	2.8×10^{-3}[(c)]	100	7.4×10^{-3}
Population within 80 km (person-rem)[d]	None	0.13	None	0.072	100	0.20
Average individual within 80 km (mrem)[e]	None	3.4×10^{-4}	None	1.9×10^{-4}	None	5.3×10^{-4}

[a] Includes direct radiation dose from surface deposits of radioactive material.

[b] The standards for individuals are given in DOE Order 5400.5 (DOE 1993a:II-1–II-5). As discussed in that order, the 10-mrem/yr limit from airborne emissions is required by the Clean Air Act, and the 4-mrem/yr limit is required by the Safe Drinking Water Act; for this SPD EIS, the 4-mrem/yr value is conservatively assumed to be the limit for the sum of doses from all liquid pathways. 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, as published in 58 FR 16268 (DOE 1993b:para. 834.7). If the potential total dose exceeds the 100 person-rem value, it is required that the contractor operating the facility notify DOE.

[c] Includes the drinking water dose.

[d] About 380,000 in 1996.

[e] Obtained by dividing the population dose by the number of people living within 80 km (50 mi) of the site.

Source: Dirkes and Hanf 1997:chap. 5.

Using a risk estimator of 500 cancer deaths per 1 million person-rem (5×10^{-4} fatal cancer per person-rem) to the public (see Appendix F.10), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from Hanford operations in 1996 is estimated to be 3.7×10^{-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 Hanford operations is less than 4 in 1 billion. (It takes several to many years from the time of radiation exposure for a cancer to manifest itself.)

According to the same risk estimator, 1×10^{-4} excess fatal cancers are projected in the population living within 80 km (50 mi) of Hanford from normal operations in 1996. To place this number in perspective, it may be compared with the number of fatal cancers expected in the same population from all causes. The 1996 mortality rate associated with cancer for the entire U.S. population was 0.2 percent per year (Famighetti 1998:964). Based on this mortality rate, the number of fatal cancers expected during 1996 from all causes in the population living within 80 km (50 mi) of Hanford was 760. This expected number of fatal cancers is much higher than the 1×10^{-4} fatal cancer estimated from Hanford operations in 1996.

Hanford workers receive the same dose as the general public from background radiation, but they also receive an additional dose from working in facilities with nuclear materials. Table 3–10 presents the average dose to the individual worker and the cumulative dose to all workers at Hanford from operations in 1996. These doses fall within the radiological regulatory limits of 10 CFR 835 (DOE 1995a:para. 835.202). According to a risk

Table 3–10. Radiation Doses to Workers From Normal Hanford Operations in 1996 (Total Effective Dose Equivalent)

	Onsite Releases and Direct Radiation	
Occupational Personnel	**Standard[a]**	**Actual**
Average radiation worker (mrem)	None[b]	19
Total workers (person-rem)[c]	None	266

[a] The radiological limit for an individual worker is 5,000 mrem/yr (DOE 1995a:para. 835.202). However, DOE's goal is to maintain radiological exposure as low as is reasonably achievable. It has therefore established an administrative control level of 2,000 mrem/yr (DOE 1994a:2-3); the site must make reasonable attempts to maintain individual worker doses below this level.

[b] No standard is specified for an "average radiation worker"; however, the maximum dose that this worker may receive is limited to that given in footnote "a."

[c] About 14,000 (badged) in 1996.

Source: Lyon 1997.

estimator of 400 fatal cancers per 1 million person-rem among workers[2] (Appendix F.10), the number of projected fatal cancers among Hanford workers from normal operations in 1996 is 0.11.

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 1996* (Dirkes and Hanf 1997). The concentrations of radioactivity in various environmental media (including air, water, and soil) in the site region (on and off the site) are also presented in that report.

3.2.4.1.2 Proposed Facility Locations

External radiation doses have been measured in the 200 and 400 Areas. In 1996, the annual doses in the 200 and 400 Areas were roughly the same, about 85 mrem. This is 10 mrem higher than the value measured at the offsite control locations. The concentration of plutonium 239/240 in air in the 200 Area in 1996 was about 1×10^{-5} pCi/m^3. Although this was about 100 times higher than the value at the control location, it was still very small. No measurements of plutonium concentrations in air were reported for the 400 Area (Dirkes and Hanf 1997:75, 76, 124, 185, 186).

3.2.4.2 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 through which people may come in contact with hazardous chemicals (e.g., surface water during swimming, soil through direct contact, or food). Hazardous chemicals can cause cancer and noncancer health effects. The baseline data for assessing potential health impacts from the chemical environment are addressed in Section 3.2.1.

[2] The risk estimator for workers is lower than the estimator for the public because of the absence from the workforce of the more radiosensitive infant and child age groups.

Effective administrative and design controls that decrease hazardous chemical releases to the environment and help achieve compliance with permit requirements (e.g., air emissions and National Pollutant Discharge Elimination System [NPDES] permit requirements) contribute to minimizing health impacts on the public. The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts on the public may occur via inhalation of air containing hazardous chemicals released to the atmosphere during normal Hanford operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water or direct exposure, are lower than those via the inhalation pathway.

Baseline air emission concentrations and applicable standards for hazardous chemicals are addressed in Section 3.2.1. The baseline 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 on estimating the health impacts of hazardous chemicals is presented in Appendix F.10.

Exposure pathways to Hanford workers during normal operations may include the inhalation of contaminants in the workplace atmosphere and direct contact with hazardous materials. The potential for health impacts varies among facilities and workers, and available information is insufficient for a meaningful estimate of impacts. However, workers are protected from workplace hazards through appropriate training, protective equipment, monitoring, substitution, and engineering and management controls. They 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 that reflects the frequency and amounts of chemicals used in the operational processes ensures that these standards are not exceeded. Additionally, DOE requires that conditions in the workplace be as free as possible from recognized hazards that cause, or are likely to cause, illness or physical harm. Therefore, workplace conditions at Hanford are substantially better than required by standards.

3.2.4.3 Health Effects Studies

Three epidemiological studies and a feasibility study have been conducted on communities around Hanford to determine whether there are 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 showed other defects statistically associated with parental 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 epidemiological studies have been carried out on the Hanford workers over the years. The studies have consistently shown a statistically significant elevated risk of death from multiple myeloma associated with radiation exposure among Hanford male workers. The elevated risk was observed only among workers exposed to 10 rads (~10 rem) or more. Other studies have also identified an elevated risk of death from pancreatic cancers, but a recent reanalysis did not conclude there was an elevated risk. Studies of female Hanford workers have shown an elevated risk of deaths from musculoskeletal system and connective tissue conditions. For a more detailed description of the studies reviewed and their findings, and for a discussion of the epidemiologic surveillance program implemented by DOE to monitor the health of current workers, refer to Appendix M.4.2 of the *Storage and Disposition PEIS* (DOE 1996a:M-224–M-230).

3.2.4.4 Accident History

Prior to 1997, there were 128 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 128 incidents fall into three significant categories, based on the seriousness of the actual or potential consequences.

Fifteen 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 (DOE 1996a:3-60).

On May 14, 1997, a chemical explosion occurred at the Hanford Plutonium Reclamation Plant in a room where nonradioactive bulk chemicals were mixed for the now-discontinued plutonium recovery process. The reclamation plant was designed to concentrate liquid feeds, dissolve and process solid material, and perform solvent-extraction recovery of plutonium from aqueous streams. Eight workers outside the plant at the time of the explosion complained of various symptoms, including headaches, light-headedness, and a strange metallic taste. All eight workers were transported to a nearby medical center, where they were examined and released. A small fire protection water line ruptured during the explosion, resulting in the release of water from the building. No one was injured and no radioactive materials were released to the environment. The explosion caused significant localized damage to the facility.

3.2.4.5 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 to most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program includes emergency planning, preparedness, and response.

Accordingly, the DOE Richland Operations Office 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 Richland Operations Office 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 Richland Operations Office, contractor, and State and local government plans are fully coordinated and integrated. Emergency control centers have been established by the DOE Richland Operations Office and its contractors for the principal work areas to provide oversight and support to emergency response actions within those areas.

Following the May 1997 explosion at Hanford (discussed previously), a review of the emergency management response indicated that multiple programs and systems failed in the hours following the accident. In a letter to Secretarial Offices, Secretary of Energy Federico Peña identified actions to be taken at all DOE sites to implement lessons learned from the emergency response (Peña 1997). The actions involve the following elements:

1. Improve training for facility and site emergency personnel
2. Ensure that equipment and qualified personnel are ready for the wide variety of potential radiological and chemical hazards
3. Improve coordination with local medical communities
4. Have in place comprehensive procedures to attend to personnel who are potentially affected by an accident

3.2.5 Environmental Justice

Environmental justice concerns the environmental impacts that proposed actions may have on minority and low-income populations, and whether such impacts are disproportionate to those on the population as a whole in the potentially affected area. In the case of Hanford, the potentially affected area includes parts of Washington and Oregon.

The potentially affected area around the 200 East Area is defined by a circle with an 80-km (50-mi) radius centered at the planned HLW vitrification facility (lat. 46E33'03.64" N, long. 119E30'13.95" W). The total population residing within that area in 1990 was 346,031. The proportion of the population that was considered minority was 26.2 percent. The potentially affected area surrounding the 400 Area is defined by a circle with an 80-km (50-mi) radius centered at FMEF (lat. 46E26'07" N, long. 119E21'55" W). The total population residing within that area in 1990 was 277,515, and the proportion of the population deemed minority was 25.4 percent. The same census data show that the percentage of minorities for the contiguous United States was 24.1, and the percentages for the States of Washington and Oregon were 13.3 and 9.2, respectively (DOC 1992).

Figure 3–5 illustrates the racial and ethnic composition of the minority population in the potentially affected area around the 200 East Area. At the time of the 1990 census, Hispanics were the largest minority group within the potentially affected area, constituting 21.5 percent of the total population. Native Americans contributed about 2 percent, and Asians, about 1.4 percent. Blacks made up about 1.2 percent of the population (DOC 1992).

As for the racial and ethnic composition of the minority population in the potentially affected area around the 400 Area, Hispanics were the largest minority group, constituting 21.5 percent of the total population during the 1990 census. Asians contributed about 1.4 percent, and Native Americans, about 2.0 percent. Blacks were about 1.2 percent of the population (DOC 1992).

A breakdown of incomes in the potentially affected area is also available from the 1990 census data (DOC 1992). At that time, the poverty threshold was $9,981 for a family of three with one related child under 18 years of age. A total of 64,780 persons (19.0 percent of the total population) residing within the potentially affected area around the 200 East Area reported incomes below that threshold. The data also show that 47,310 persons (17.3 percent of the total population) residing within the potentially affected area around the 400 Area reported incomes below the poverty threshold. Data obtained during the 1990 census also show that of the total population of the contiguous United States, 13.1 percent reported incomes below the poverty threshold, and that the figures for Washington and Oregon were 10.9 and 12.4 percent, respectively.

3.2.6 Geology and Soils

Geologic resources are consolidated or unconsolidated earth materials, including 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.

3.2.6.1 General Site Description

The rocks beneath Hanford consist of Miocene-age and younger rocks that overlay older Cenozoic sedimentary and volcanic basement rocks. The major geologic units underlying Hanford are, in ascending order: subbasalt (basement) rocks, the Columbia River Basalt Group (with alluvial interbeds of sand, gravel, or silt of the Ellensburg Formation), the Ringold Formation, the Plio-Pleistocene unit, early "Palouse" soil, and the Hanford Formation (DOE 1996a:3-38; DOE 1996c:4-5).

Basalt outcrops are exposed on ridges at Gable Mountain, Gable Butte, and the Saddle Mountains in the northern part of Hanford, and on Rattlesnake Hills and Yakima Ridge, overlapping the western and southwestern edges

of Hanford (DOE 1996a:3-38). Other than crushed rock, sand, and gravel, no economically viable geologic resources have been identified at Hanford (DOE 1996c:4-10).

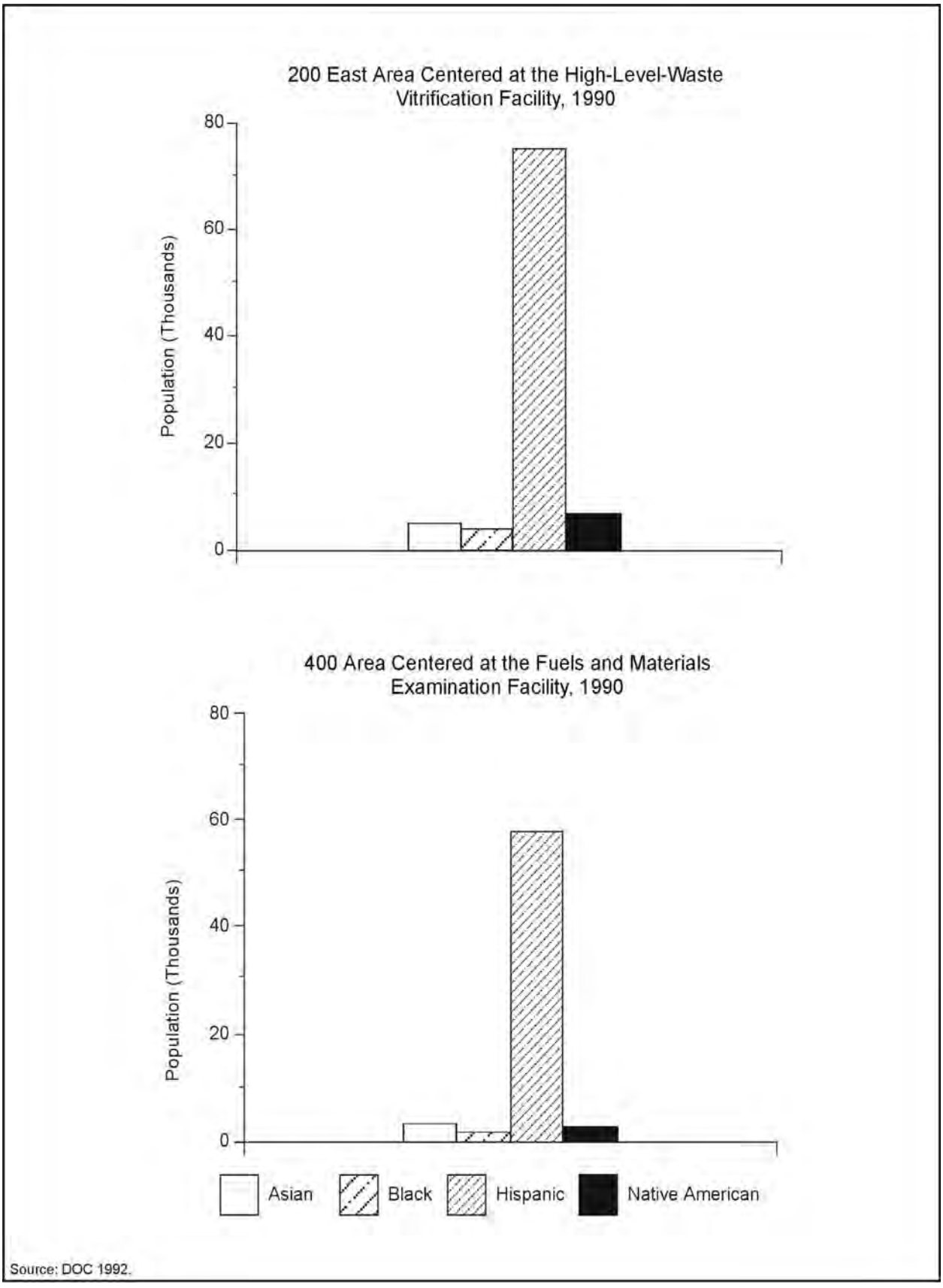


Figure 3–5. Racial and Ethnic Composition of Minorities Around Hanford

Known faults in the Hanford area include those on Gable Mountain and the Rattlesnake-Wallula alignment. The faults in Central Gable Mountain are considered capable, although there is no observed seismicity on or near Gable Mountain. The Rattlesnake-Wallula alignment is interpreted as possibly being capable because there appear to be active portions of the fault system 56 km (35 mi) southwest of the central part of Hanford. A capable fault is one that has had movement at or near the ground surface at least once within the past 35,000 years or recurrent movement within the past 500,000 years (Barghusen and Feit 1995:2.2-13, 2.2-14).

According to the Uniform Building Code, Hanford is in Seismic Zone 2B, meaning that moderate damage could occur as a result of an earthquake. Seismicity of the Columbia Plateau, as determined by the rate of earthquakes per area and the historical magnitude of these events, is lower than that of other regions in the Pacific Northwest (DOE 1996a:3-38, 3-39). The two largest earthquakes near Hanford occurred in 1918 and 1973; each had an approximate Richter magnitude of 4.5 and a Modified Mercalli Intensity of V. They occurred in the central portion of the Columbia Plateau north of Hanford (Neitzel 1996:4.49). An earthquake with a maximum horizontal acceleration of 0.25g is calculated to have an annual probability of occurrence of 1 in 10,000 at Hanford (Barghusen and Feit 1995:2.2-14).

There is some potential for slope failure at Hanford, although only the slopes of Gable Mountain and White Bluffs are steep enough to warrant 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. A large landslide along White Bluffs could fill the Columbia River channel and divert water onto Hanford (DOE 1996a:3-40). Calculations of the potential impacts of such a landslide indicate a flood area similar to the probable maximum flood (Neitzel 1996:4.58–4.61).

Several major volcanoes are in the Cascade Range west of Hanford, including Mount Adams, 164 km (102 mi) from Hanford, and Mount St. Helens, 218 km (135 mi) west-southwest of the site (DOE 1996a:3-40). Ashfalls from at least three Cascade volcanoes have blanketed the central Columbia Plateau since the late Pleistocene epoch. Generally, ashfall layers have not exceeded more than a few centimeters in thickness, with the exception of the Mount Mazama (Crater Lake, Oregon) eruption, when as much as 10 cm (3.9 in) of ash fell over western Washington (Barghusen and Feit 1995:2.2-14).

Fifteen different soil types occur at Hanford. These soils vary from sand to silty and sandy loam. The dominant soil types are the Quincy (Rupert) sand, Burbank loamy sand, Ephrata sandy loam, and the Warden silt loam. No soils at Hanford are currently classified as prime farmlands because there are no current soil surveys, and the only prime farmland soils in the region are irrigated (DOE 1996b:4-15). The soils at Hanford are considered acceptable for standard construction techniques (DOE 1996a:3-40). More detailed descriptions of the geology and the soil conditions at Hanford are included in the *Storage and Disposition PEIS* (DOE 1996a:3-38–3-40) and the *Hanford Remedial Action EIS* (DOE 1996b).

3.2.6.2 Proposed Facility Locations

The nearest capable fault to the 200 East Area is about 10 km (6.2 mi) away (Mecca 1997a:6). The predominant soils of the 200 East Area are the Burbank loamy sand and the Ephrata sandy loam, and the soils are not subject to liquefaction or other instabilities (Mecca 1997a:6; Neitzel 1996:4-46).

The nearest capable fault to the 400 Area is about 19 km (12 mi) away (Mecca 1997a:6). The predominant soil type in the 400 Area is the Rupert sand, and the soils are not subject to liquefaction or other instabilities (Mecca 1997a:6; Neitzel 1996:4-46).

3.2.7 Water Resources

3.2.7.1 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.

3.2.7.1.1 General Site Description

The major surface water features at Hanford are the Columbia River, the Yakima River, the springs along the Columbia River and on Rattlesnake Mountain, and onsite ponds. Flow of the Columbia River is regulated by several dams upstream and downstream from the site. The nearest dam upstream from Hanford is the Priest Rapids Dam, and the closest downstream dam is the McNary Dam. The Hanford Reach is the portion of the Columbia River that extends from Priest Rapids Dam to the upstream edge of the pool behind McNary Dam. Because the flows are regulated, flow rates in the Hanford Reach can vary considerably; it is the last remaining free-flowing, nontidal section of the river (DOE 1996a:3-32). The average flow rate at the Priest Rapids Dam is about 3,360 m^3/s (118,700 ft^3/s). About one-third of the Hanford Site drains into the Yakima River, which forms a portion of the southern site boundary (Neitzel 1996:4.53–4.55). The average annual flow rate for the Yakima River is about 104 m^3/s (3,670 ft^3/s). Rattlesnake Springs and Snively Springs are in the southwestern portion of the site and flow into intermittent streams. Flows received by these streams infiltrate rapidly into the surface sediments thereof (DOE 1996a:3-32).

Waters of the Columbia River are used primarily for hydroelectric power, transportation, irrigation and other agricultural purposes, recreation, and municipal domestic water. Hanford uses water from the river for domestic and industrial purposes (DOE 1996a:3-32).

Flooding of the site has occurred along the Columbia River, but chances of recurrence have been greatly reduced by the construction of dams to regulate river flow. No maps of flood-prone areas have been produced by the Federal Emergency Management Agency (FEMA). FEMA produces these maps for areas capable of being developed, and the Hanford Site is not designated for commercial or residential development (DOE 1996b:4-22). However, analyses have been completed to determine the potential for the probable maximum flood. This is determined through hydrologic factors, including the amount of precipitation within the drainage basin, snow melt, and tributary conditions. The probable maximum flood for the Columbia River below the Priest Rapids Dam has been calculated at 39,600 m^3/s (1.4 million ft^3/s). Figure 3–6 shows the elevations of the highest flood of record, the river at normal flow, the 1948 flood, and the probable maximum flood (DOE 1996b:4-23).

Potential flooding due to dam failure has been evaluated by the U.S. Army Corps of Engineers (USACE). Upstream failures could have any number of causes, the magnitude of the resultant flooding depending on the size of the breach in the dam. USACE evaluated various scenarios for failure of the Grand Coulee Dam and assumed flow conditions of about 11,300 m^3/s (400,000 ft^3/s). The worst-case scenario assumed a 50 percent breach in the dam (Figure 3–7). The flood wave from an instantaneous 50 percent breach was calculated to be 595,000 m^3/s (21 million ft^3/s). In addition to the areas affected by the probable maximum flood, the remainder of the 100 Area, the 300 Area, and nearly all of Richland, Washington, would be flooded. Determinations were not made for larger instantaneous breaches in the Grand Coulee Dam, because the 50 percent scenario was believed to be the largest conceivable flow from a natural or manmade breach. It was not considered credible that a structure as large as the Grand Coulee Dam could be 100 percent destroyed instantaneously. The analysis also assumed that the 50 percent breach would occur only as the result of direct explosive detonation, and not because of some natural event such as an earthquake (DOE 1996b:4-24).

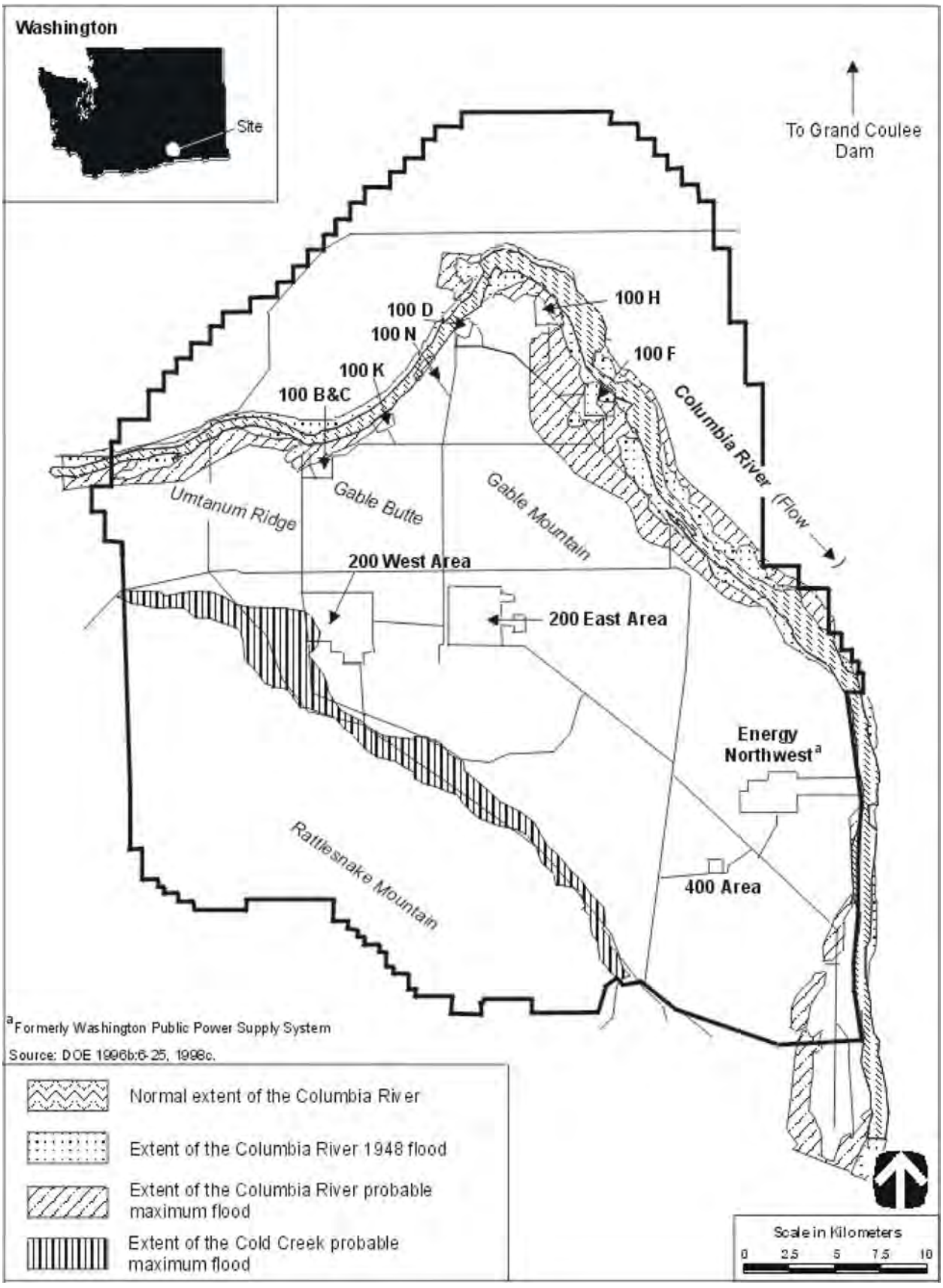


Figure 3–6. Flood Area for the Probable Maximum Flood and Columbia River 1948 Flood

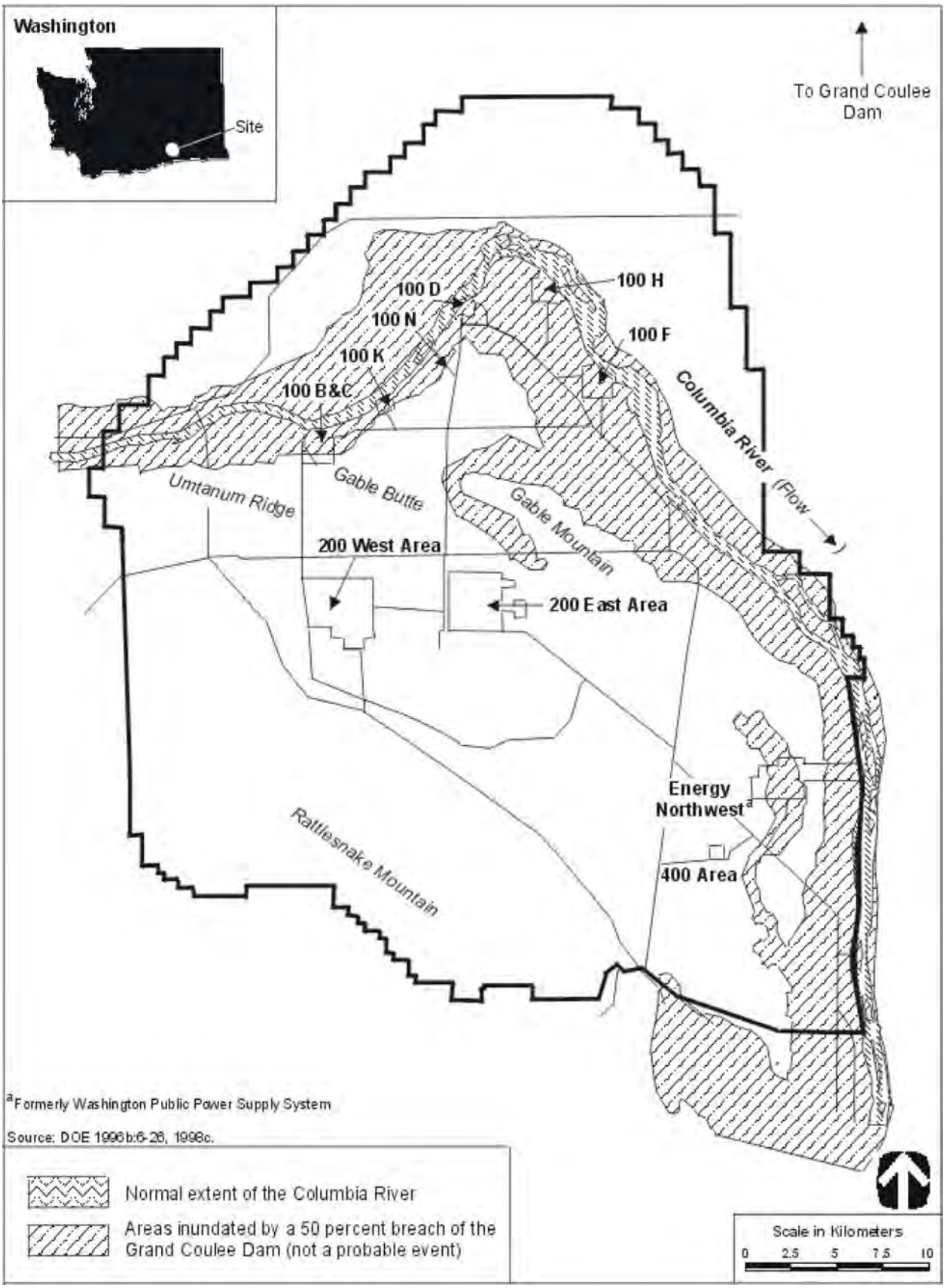


Figure 3–7. Flood Area of a 50 Percent Breach of the Grand Coulee Dam

The possibility of a landslide resulting in river blockage has also been evaluated for White Bluffs. Calculations were made for a landslide volume of 765,000 m^3 (1 million yd^3) with a concurrent flow of about 17,000 m^3/s (600,000 ft^3/s) in the river, which is the 200-year flood. This combination resulted in a flood wave crest elevation of 122 m (400 ft) above mean sea level, similar to that from the 50 percent breach of the Grand Coulee Dam (DOE 1996b:4-24).

The Hanford Reach has been classified Class A: excellent drinking water, a recreation area, and wildlife habitat (DOE 1996a:3-32; Dirkes and Hanf 1996:113). The river currently meets applicable drinking water and water quality standards. No federally designated Wild and Scenic Rivers exist on Hanford, although consideration is being given to so designating the Hanford Reach (Barghusen and Feit 1995:2.2-17–2.2-19).

DOE continues to assert a federally reserved water withdrawal right for the Columbia River. Currently, Hanford withdraws approximately 13.5 billion l/yr (3.6 billion gal/yr) from the Columbia River (DOE 1996a:3-34).

Hanford has six NPDES-permitted discharges and two NPDES permits for these discharges. One permit, WA-000374-3, includes five discharges in the 100 and 300 Areas. A request for a minor permit modification to delete two inactive outfalls from the 100 N-Area was submitted to EPA in August 1995. No effluent noncompliance issues were associated with any of these outfalls in 1995 (Dirkes and Hanf 1996:31, 32).

Permit #WA-002592-7 was issued for the 300 Area Treated Effluent Disposal Facility, which had 10 permit exceedances in 1996. This disposal facility was in normal operations and meeting design specifications at the time of these events. All indications suggest that the facility is unable to consistently meet the restrictions of the facility's NPDES permit despite the use of the best available technology (Dirkes and Hanf 1997:36). An application for a permit modification was submitted to the EPA in November 1997. A revised permit is expected to be issued in 1998 (Sandberg 1998b).

Hanford received a general storm-water permit in February 1994. The *Annual Site Compliance Evaluation and the Pollution Prevention Plan* was updated as required by the permit. No noncompliances were associated with this permit in 1995 (Dirkes and Hanf 1996:32).

All radiological contaminant concentrations measured in the Columbia River in 1995 were lower than the DOE-derived concentration guides and Washington State ambient surface water quality criteria (Dirkes and Hanf 1996:114). For nonradiological parameters, applicable standards for Class A–designated surface water were met; however, the minimum detectable concentration of silver exceeded the Washington State toxicity standard. During 1995, there was no evidence of deterioration in water quality attributable to Hanford operations along the Hanford Reach (Dirkes and Hanf 1996:119).

The Columbia River is also the primary discharge area for the unconfined aquifer underlying Hanford. The site conducts sampling of these discharges and refers to them as riverbank springs. Hanford-origin contaminants continued to be detected in riverbank spring water during 1995. The location and extent of the contaminated discharges were consistent with recent groundwater surveys. Tritium; strontium 90; technetium 99; uranium 234, 235, and 238; cadmium; chloroform; chromium; copper; nitrate; trichloroethylene (TCE); and zinc entered the river along the 100 Area shoreline. Tritium; technetium 99; iodine 129; uranium 234, 235, and 238; chromium; nitrate; and zinc entered the river along the portion extending from the old Hanford Townsite to below the 300 Area. All radiological contaminants in these discharges were below DOE-derived concentration guides. With the exception of TCE, the concentrations of all anion and volatile organic compounds measured in riverbank spring water collected from the Hanford shoreline were below Washington State ambient surface water quality criteria. The concentration of TCE exceeded the EPA standard for protection of human health for the consumption of water and organisms in the 100 K-Area riverbank spring (Dirkes and Hanf 1996:124–126, 132).

3.2.7.1.2 Proposed Facility Locations

The water source in the 200 Area is the Hanford export water system that withdraws Columbia River water at the 100 B-Area pumphouse (Mecca 1997a:5, 7). Most of the Hanford Site is supplied with water from this system. Water is withdrawn at a rate of about 36.2 million l/day (9.6 million gal/day). This system provides water to other areas of the site, but since the shutdown of the reactors its primary function is to provide water to the 200 Area (Mecca 1997a:145–147). More detailed information on this water system may be found in Section 3.2.11.

The 200 East Area sits on a plateau about 11 km (6.8 mi) south of the Columbia River (Mecca 1997a:120; Barghusen and Feit 1995:2.2-8). In this area, only the East Powerhouse Ditch and the 216-B-3C Pond are active. The pond was originally excavated in the mid-1950s for disposal of process cooling water and other liquid waste occasionally containing low levels of radionuclides. West Lake, north of the 200 East Area, is predominantly recharged from groundwater. The lake has not received direct effluent discharges from site facilities; it owes its existence to the intersection of the elevated water table with the land surface in the topographically low area south of Gable Mountain and north of the 200 East Area (Neitzel 1996:4.61).

Analyses of maximum flooding scenarios have indicated that the 200 East Area would not be flooded, even in the worst-case scenario of a failure of the Grand Coulee Dam (Neitzel 1996:4.55–4.61; ERDA 1976:1–11). Similar results have been produced by landslide analyses—specifically, analysis of a landslide-induced blockage of the Columbia River at White Bluffs. Such a blockage would cause flooding, but it would not impact the 200 East Area facilities (Neitzel 1996:4-58).

The 400 Area receives its water from three wells that have a total capacity of about 397 million l/yr (105 million gal/yr) (Mecca 1997a:780). Two other wells would provide emergency service if these wells failed, and another, dire emergency service if all other wells failed. Chlorination is the only treatment provided to these wells (Dirkes and Hanf 1996:140).

No specific flooding analyses have been completed for the 400 Area, but analyses have been completed for the site as a whole. According to the sitewide data, the elevation of the ground surface in the 400 Area is about 30 m (100 ft) above that of the maximum calculated flood from a 50 percent breach in the Grand Coulee Dam (Mecca 1997a:4). Also, the 400 Area is above the elevation of the maximum historical flood of 1894 (Neitzel 1996:4.56).

3.2.7.2 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.

3.2.7.2.1 General Site Description

Groundwater under Hanford occurs in confined and unconfined aquifers. The unconfined aquifer lies within the glacioalluvial sands and gravels of the Hanford Formation and the fluvial and lacustrine sediments of the Ringold Formation. Groundwater generally flows eastward across the site; because of local water disposal practices, however, the water table has risen as much as 27 m (89 ft) in the 200 West Area. This has caused groundwater mounding with radial and northward flow components in the 200 Area. Depth to groundwater across the site ranges from 24 to 80 m (79 to 262 ft) (DOE 1996a:3-34).

The unconfined aquifer is recharged mainly from rainfall and runoff from the higher elevation on the western border and from artificial recharge from irrigation and wastewater disposal practices at Hanford. In the vicinity of Hanford, groundwater is discharged along the Columbia River, and some lesser amounts along the Yakima River (DOE 1996a:3-34).

The confined aquifers at Hanford consist of sedimentary interbeds and interflow zones that occur between basalt flows in the Columbia River Basalt Group. Aquifer thickness varies from several centimeters to at least 52 m (171 ft). Recharge of the confined aquifer occurs where the basalt formations are near ground level, and thus surface water is allowed to infiltrate them. Groundwater from the confined aquifers discharges to the Columbia River (DOE 1996a:3-34).

Water use in the Pasco Basin, which includes Hanford, is primarily via surface water diversion; groundwater accounts for less than 10 percent of water use. While most of the water used by Hanford is surface water withdrawn from the Columbia River, some groundwater is used. One of the principal users of groundwater was FFTF, which used about 697,000 l/day (184,000 gal/day) when it operated. The other facilities that use groundwater are the Yakima Barricade and the Patrol Training Academy (Dirkes and Hanf 1996:139–144; Barghusen and Feit 1995:2.2-21–2.2-24). DOE currently asserts an unlimited federally reserved groundwater withdrawal right with respect to the existing Hanford operations and withdraws about 195 million l/yr (52 million gal/yr) (DOE 1996a:3-37).

Groundwater quality beneath portions of the Hanford Site from the 200 Areas north and east to the Columbia River has been affected by past liquid waste disposal practices and as a result of spills and leaks from single-shell radioactive waste storage tanks (Dirkes and Hanf 1997:95). The unconfined aquifer contains radiological and nonradiological contaminants at levels exceeding water quality criteria and standards. Contamination in the confined aquifer is typically limited to areas of exchange with the unconfined aquifer. Tritium and nitrate plumes have moved steadily eastward across the site and seeped into the Columbia River. No aquifers have been designated sole-source aquifers (Barghusen and Feit 1995:2.2-22).

3.2.7.2.2 Proposed Facility Locations

Two major groundwater mounds have been formed in the 200 Area, both in response to wastewater discharges. The first was created by disposal at U Pond in the 200 West Area. This mound has been slowly dissipating since the pond was decommissioned in 1984. The second major mound was created by discharges to B Pond east of the 200 East Area. The water table near B Pond increased to a maximum of about 9 m (30 ft) above preoperational conditions in 1990, and has dropped slightly over the last few years because of the reduced volume of discharges. These mounds have altered the unconfined flow patterns that generally recharge from the west and flow to the east. Water levels in the unconfined aquifer continually change as a result of variations in the volume and location of wastewater discharges. Consequently, the movement of groundwater and its associated constituents has also changed with time (Dirkes and Hanf 1996:185).

The radiological contaminants in two 200 East Area groundwater plumes include cesium 137, cobalt 60, plutonium, strontium 90, technetium 99, and tritium. They are the result of historical reprocessing operations at B Plant. Two pump-and-treat test systems used in treatability testing of these plumes were discontinued in May 1995 after about 5 million l (1.3 million gal) of water were treated. Decisions concerning further actions have been deferred until the data are evaluated. A RCRA Field Investigation/Corrective Measures Study addressing contaminants associated with PUREX Plant discharges is being prepared (Dirkes and Hanf 1996:197–219).

In the 400 Area, groundwater flows to the east. The flow direction at the Nonradioactive Dangerous Waste Landfill and the Solid Waste Landfill, which are nearby, is east-southeast. Because of their rather high

permeabilities, Hanford Formation sediments dominate groundwater flows in these areas. Transmissivity of the unconfined aquifer system in the landfill areas is particularly high, because the system is within the main flow channel of the catastrophic floods that deposited the Hanford Formation gravels. In the 400 Area, the Hanford Formation consists mainly of the sand-dominated facies, and the water table is near the point of contact between the Hanford and Ringold Formations. Transmissivity of the aquifer in the 400 Area is an order of magnitude lower than that in the landfill areas (Hartman and Dresel:1997:3.11, 3.12). Water for the 400 Area is supplied by three wells in the unconfined aquifer. Each well has a pumping capacity of 83.3 l/min (22 gal/min). The water is distributed throughout the 400 Area for potable, process, and fire protection use (Dirkes and Hanf 1997:193; Rohl 1994:2-7).

Nitrate is the only significant contaminant attributable to 400 Area operations. Elevated levels have been attributed to the sanitary sewage lagoon, a source of groundwater contamination that should be eliminated by a recently constructed sewage treatment system. Other contamination found in well samples is believed not to emanate from the 400 Area (Hartman and Dresel 1997:6.90).

3.2.8 Ecological Resources

Ecological resources are defined as terrestrial (predominantly land) and aquatic (predominantly water) ecosystems characterized by the presence of native and naturalized plants and animals. For the purposes of this SPD EIS, those ecosystems are differentiated in terms of habitat support of threatened, endangered, and other special-status species—that is, "nonsensitive" versus "sensitive" habitat.

3.2.8.1 Nonsensitive Habitat

Nonsensitive habitat comprises those terrestrial and aquatic areas of the site that typically support the region's major plant and animal species.

3.2.8.1.1 General Site Description

Hanford is made up of large, undisturbed expanses of shrub-steppe habitat that supports nearly 600 plant species and numerous animal species suited to the region's semiarid environment (DOE 1996d:3-89, 3-90). Present site development consists of clusters of large buildings at widely spaced locations, occupying about 6 percent of the total available area. The remaining site area can be divided into 10 major plant communities (see Figure 3–8). The dominant plants are cheatgrass, big sagebrush, rabbitbrush, and Sandberg's bluegrass, with cheatgrass providing at least half of the total plant coverage. Shrub-steppe is considered a priority habitat by the State of Washington because of its significant value to sensitive wildlife. Trees that were originally planted on farmland to provide windbreaks and shade serve as nesting platforms for several species of birds, including hawks, owls, ravens, magpies, and great blue herons, and as night roosts for wintering bald eagles (DOE 1996a:3-42; DOE 1996b:4-51).

Animal species at Hanford include over 1,000 species of insects, 12 species of amphibians and reptiles, 214 species of birds, 44 species of fish, and 39 species of mammals (Dirkes and Hanf 1997:275). Grasshoppers and darkling beetles are among the more conspicuous groups, and along with other species, are important in the food web of the local birds and mammals. The most abundant reptile is the side-blotched lizard, although short-horned and sagebrush lizards, gopher snakes, yellow-bellied racers, and Pacific rattlesnakes are also seen frequently. The horned lark and western meadowlark are the most abundant nesting birds, but the site also supports populations of chukar partridge, gray partridge, and sage grouse (DOE 1996d:3-90). The Hanford Reach, including several sparsely vegetated islands, provides nesting habitat for the Canadian goose, ring-billed gull, Forster's tern, and great blue heron. Numerous raptors, such as the northern harrier, ferruginous hawk, Swainson's hawk, red-tailed hawk, prairie falcon, American kestrel, and owls, use the site as a refuge, especially during nesting (DOE 1996a:3-42; DOE 1996b:4-56; DOE 1996e:3-90). Mammals on the site are generally small

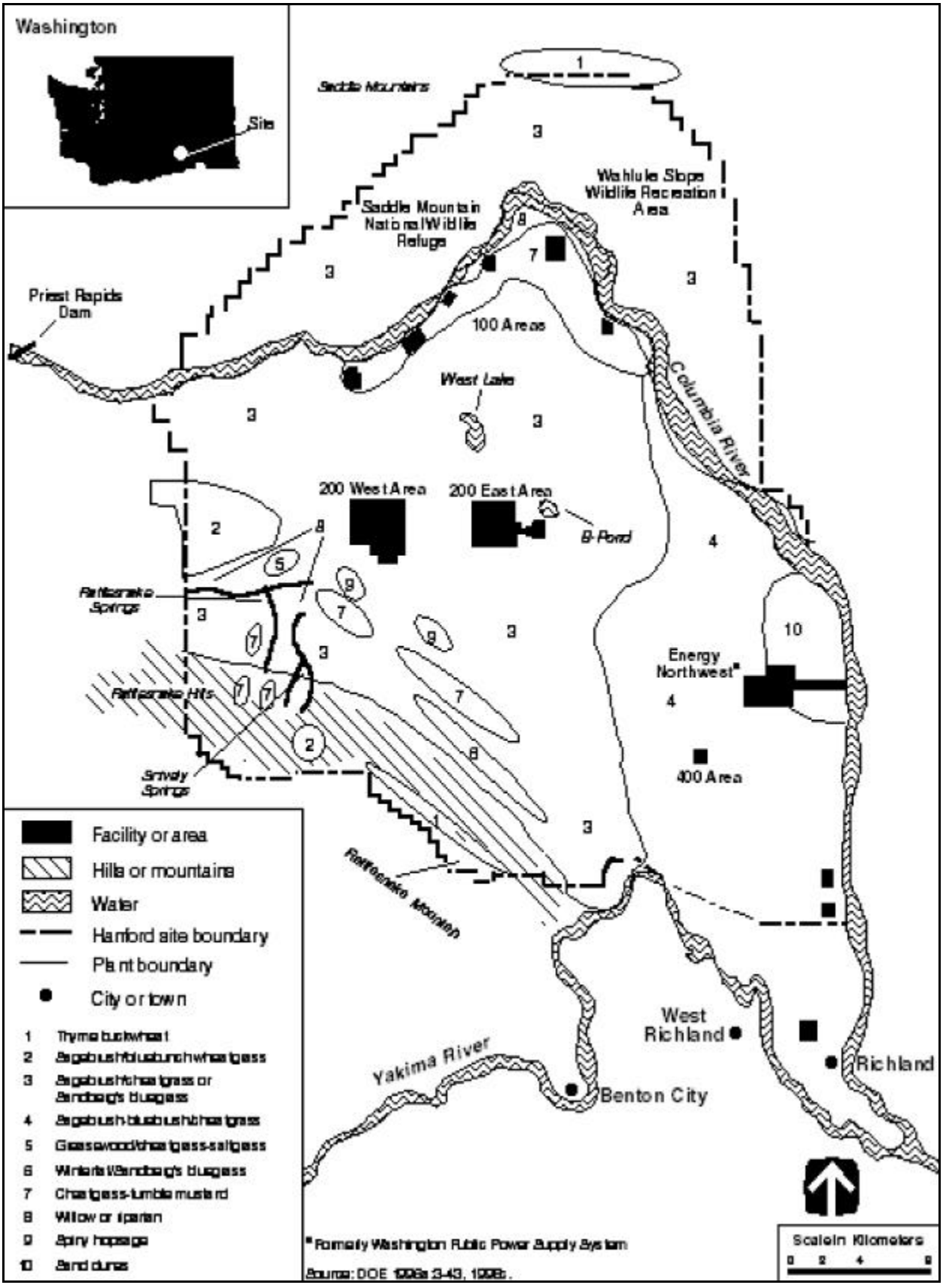


Figure 3–8. Major Plant Communities at Hanford

and nocturnal, the Great Basin pocket mouse being the most abundant. Other small mammals include the deer mouse, Townsend ground squirrel,pocket gopher, harvest mouse, Norway rat, sagebrush vole, grasshopper mouse, montane vole, vagrant shrew, Leasts chipmunk, and Merriam's shrew. Larger mammals include the mule deer and elk. Small numbers of bobcats and badgers also inhabit the site. The largest predator, which ranges all across the site, is the coyote. Bat species include the pallid bat, which frequents deserted buildings and is thought to be the most abundant. Other species include the hoary bat, silver-haired bat, California brown bat, little brown bat, Yuma brown bat, and Pacific western big-eared bat (DOE 1996b:4-55; DOE 1996d:3-90).

There are two types of natural aquatic habitats on the Hanford Site. The dominant one, the Columbia River, flows along the northern and eastern edges; the other is the small spring-streams and seeps in the Rattlesnake Hills. Several artificial water bodies, primarily ponds and ditches, have been formed as a result of wastewater disposal practices associated with the operation of reactors and separation facilities. Although they are temporary and will vanish with cessation of activities, all except West Lake form established aquatic ecosystems when present. West Lake is created by a rise in the water table in the 200 Areas, and because it is not fed by surface flow, it is alkaline and has limited plant and animal species (DOE 1996b:4-63).

The Columbia River supports a large and diverse community of plankton, benthic invertebrates, fish, and other aquatic organisms. The Hanford Reach supports transient phytoplankton and zooplankton populations and 44 anadromous and resident species of fish (DOE 1996d:3-90). Of these species, the chinook salmon, sockeye salmon, coho salmon, and steelhead trout use the river as a migration route to upstream spawning areas. Principal resident fish species sought by anglers include whitefish, sturgeon, smallmouth bass, catfish, walleye, and perch. There are also large populations of rough fish present, including carp, shiners, suckers, and squawfish. Small spring-streams, such as Rattlesnake and Snively Springs, support diverse biotic communities and are extremely productive, consisting of dense blooms of watercress and aquatic insects (DOE 1996b:4-63, 4-64). Temporary wastewater ponds and ditches develop riparian communities and are attractive to migrating birds in autumn and spring (DOE 1996e:3-90).

3.2.8.1.2 Proposed Facility Locations

Biological surveys in the 200 East Area and immediately surrounding areas show that approximately 40 percent of the area is big sagebrush and grey rabbitbrush, both native species characteristic of shrub-steppe communities. Roughly 20 percent is Russian thistle, the remainder being either disturbed vegetation or bare gravel (DOE 1996c:4-32). Because of past disturbances and human occupancy in the 200 Areas, wildlife associated with shrub-steppe habitat is somewhat limited (DOE 1996c:S-7). Several animal species may be found in this area. Bird species include the burrowing owl, ferruginous hawk, great blue heron, loggerhead shrike, long-billed curlew, northern harrier, sage sparrow, Swainson's hawk, western meadowlark, vesper sparrow, and horned lark. Potential mammal species include the black-tailed jackrabbit, coyote, Great Basin pocket mouse, house mouse, deer mouse, mule deer, Nuttall's cottontail, raccoon, and badger. Reptiles likely to be seen include the gopher snake, northern Pacific rattlesnake, western yellow-bellied racer, and side-blotched lizard (Mecca 1997b:Poston memo to Teal).

The 400 Area is characterized as postfire shrub-steppe habitat dominated by cheatgrass and small shrubs, including gray and green rabbitbrush. Generally, the same animal species listed above as potentially located in the 200 Area may be found in the 400 Area, with the following exceptions: great blue heron, raccoon, and badger. Species that may be infrequently seen due to limited habitat as a result of fire include loggerhead shrike and sage sparrow (Mecca 1997b:Poston memo to Teal). No surface water flows within 1.6 km (1 mi) of the proposed facility locations in the 200 East and 400 Areas (Mecca 1997b).

3.2.8.2 Sensitive Habitat

Sensitive habitat comprises those terrestrial and aquatic (including designated wetlands) areas of the site that support threatened and endangered, State-protected, and other special-status plant and animal species.[3]

3.2.8.2.1 General Site Description

The primary jurisdictional wetlands on the Hanford Site are found along the Hanford Reach and include the riparian and riverine habitats associated with the river shoreline (DOE 1996b:4-64). The riparian zone varies with seasonal water-level fluctuations and daily variations related to power generation at Priest Rapids Dam, but is known to support extensive stands of willows, grasses, various macrophytes, and other plants. Other large areas of wetlands can be found within the Saddle Mountain National Wildlife Refuge and the Wahluke Slope Wildlife Recreation Area. Wetland habitat in these areas consists of large ponds resulting from irrigation runoff. The ponds support extensive stands of cattails and other emergent aquatic vegetation that are frequently used as nesting sites by waterfowl (DOE 1996a:3-42).

Sixty-five threatened, endangered, and other special-status species listed by the Federal Government or the State of Washington may be found in the vicinity of Hanford, as shown in Table 3.2.6–1 of the *Storage and Disposition PEIS* (DOE 1996a:3-45).

3.2.8.2.2 Proposed Facility Locations

Riparian habitats are associated with the B Pond Complex near the 200 East Area and a small cooling and wastewater pond in the 400 Area (DOE 1996b:4-64). Wetland plants occurring along the shoreline of B Pond include herbaceous and woody species such as showy milkweed, western goldenrod, three square bulrush, horsetail rush, common cattail, and mulberry. Wildlife species observed include a variety of mammals and waterfowl (DOE 1996c:4-33). Similar representative plants and animals may be found in the 400 Area, with the exception of bulrushes, cattails, horsetails, and mulberry (Mecca 1997a:Poston memo to Teal).

No animals or plants on the Federal list of threatened and endangered species are known to occur on or around the 400 Area and 200 East Area. As indicated in Table 3–11, the State of Washington has classified eight bird, one mammal, four plant, and two reptile species as threatened, endangered, or species of concern. Loggerhead shrike and sage sparrow nest in undisturbed sagebrush habitat. Other bird species of concern that may occur in shrub-steppe habitat are the burrowing owl, ferruginous hawk, golden eagle, long-billed curlew, sage thrasher and Swainson's hawk. The only mammal species is the State-listed endangered pygmy rabbit which have only rarely been observed at Hanford. Pipers daisy has been found at B Pond near the 200 East Area and crouching milkvetch, stalked-pod milkvetch, and squill onion are also found in the vicinity. The reptile species of concern are the desert night snake and striped whipsnake (Dirkes and Hanf 1997:F.1–F.3; DOE 1996a:3-44; DOE 1996c:4-34).

3.2.9 Cultural and Paleontological Resources

Cultural resources are human imprints on the landscape and are defined and protected by a series of Federal laws, regulations, and guidelines. Hanford has a well-documented record of cultural and paleontological resources. The *Hanford Cultural Resources Management Plan*, approved by the State Historic Preservation Officer (Battelle 1989), establishes guidance for the identification, evaluation, recordation, curation, and management of

[3] The Federal Government defines threatened and endangered species in the Endangered Species Act, and wetlands in 33 CFR 328.3.

these resources. There are 645 cultural resource sites and isolated finds recorded. Forty-eight archaeological sites and one building are included on the National Register of Historic Places. Nominations have been prepared

Table 3–11. Threatened and Endangered Species, Species of Concern, and Sensitive Species Occurring or Potentially Occurring in the Vicinity of 200 East Area and 400 Area

Common Name	Scientific Name	Federal Status	State Status
Birds			
Burrowing owl	*Athene cunicularia*	Species of Concern	Candidate Species
Ferruginous hawk	*Buteo regalis*	Species of Concern	Threatened
Golden eagle	*Aquila chrysaetos*	Not listed	Candidate Species
Loggerhead shrike	*Lanius ladovicianus*	Species of Concern	Candidate Species
Long-billed curlew	*Numenius americanus*	Not listed	Candidate Species
Sage sparrow	*Amphispiza belli*	Not listed	Candidate Species
Sage thrasher	*Oreoscoptes montanus*	Not listed	Candidate Species
Swainson's hawk	*Buteo swainsoni*	Not listed	Candidate Species
Mammals			
Pygmy rabbit	*Brachylagus idahoenis*	Species of Concern	Endangered
Plants			
Crouching milkvetch	*Astragalus succumbens*	Not listed	Monitor Group 3[a]
Piper's daisy	*Erigeron piperianus*	Not listed	Sensitive
Squill onion	*Allium scillioides*	Not listed	Monitor Group 3[a]
Stalked-pod milkvetch	*Astragalus sclerocarpus*	Not listed	Monitor Group 3[a]
Reptiles			
Desert night snake	*Hypsiglena torquata*	Not listed	Monitor Group
Striped whipsnake	*Masticophis taeniatus*	Not listed	Candidate Species

[a] Taxa that are more abundant or less threatened than previously assumed.

Source: Dirkes and Hanf 1997:F.1–F.3; DOE 1996c:4-34; McConnaughey 1998; Roy 1998.

for several archaeological districts and sites considered to be eligible for listing on the National Register. While many significant cultural resources have been identified, only about 6 percent of Hanford has been surveyed, and few of the known sites have been evaluated for their eligibility for listing on the National Register. Cultural resource reviews are conducted whenever projects are proposed in previously unsurveyed areas. In recent years, reviews have exceeded 500 per year (DOE 1996b:4-68, 4-69).

Cultural sites are often occupied continuously or intermittently over substantial time spans. For this reason, a single location (sites) may contain evidence of use during both historic and prehistoric periods. In the discussions that follow, the numbers of prehistoric and historic resources are presented; the sum of these resources may be greater than the total number of sites reported due to this dual-use history at sites. Therefore, where the total number of sites reported is less than the sum of prehistoric and historic sites certain locations were used during both periods.

3.2.9.1 Prehistoric Resources

Prehistoric resources are physical properties that remain from human activities that predate written records.

3.2.9.1.1 General Site Description

Currently, 283 prehistoric sites have been identified, 17 of which contain historic components. Of 48 sites included on the National Register, 2 are individual sites (Hanford Island Site and Paris Site), and the remainder are located in seven archaeological districts. In addition, four other archaeological districts have been nominated or are planned to be nominated for the National Register. A number of sites have been identified along the Middle Columbia River and in inland areas away from the river, but near other water sources. Some evidence of human occupation has been found in the arid lowlands. Sites include remains of numerous pithouse villages, various types of open campsites, graves along the riverbanks, spirit quest monuments (rock cairns), hunting camps, game drive complexes, quarries in mountains and rocky bluffs, hunting and kill sites in lowland stabilized dunes, and small temporary camps near perennial sources of water away from the river (DOE 1996b:4-69, 4-70).

More than 10,000 years of prehistoric human activity in the largely arid environment of the Middle Columbia River region have left extensive archaeological deposits. Archaeological surveys have been conducted at Hanford since 1926; however, little excavation has been conducted at any of the sites. 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 riverbanks 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 (DOE 1996a:3-48).

3.2.9.1.2 Proposed Facility Locations

An archaeological survey has been conducted for all undeveloped portions of the 200 East Area and half of the undeveloped portions of the 200 West Area. 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. Likewise, most of the 400 Area is disturbed and is unlikely to contain intact prehistoric or historic sites. A cultural resources survey found only 12 ha (30 acres) that were undisturbed, and no sites were identified either within the 400 Area or within 2 km (1.2 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 (DOE 1996a:3-48).

3.2.9.2 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.

3.2.9.2.1 General Site Description

There are 202 historic archaeological sites and other historic localities recorded at Hanford. Of these sites, 1 is included on the National Register as a historic site, and 56 are listed as archaeological sites. Sites and localities that predate the Hanford era 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. More recent historic structures include the defense reactors and associated materials-processing facilities that played an important role in the Manhattan Project and the Cold War era (DOE 1996a:3-48, 3-49).

Lewis and Clark were the first European Americans to visit this region, during their 1804 to 1806 expedition. They were followed by fur trappers, military units, and miners. It was not until the 1860s that merchants set up stores, a freight depot, and the White Bluffs Ferry on the Hanford Reach, and Chinese gold miners began to work the gravel bars. Cattle ranches opened in the 1880s, and farmers soon followed. Several small thriving towns, including Hanford, White Bluffs, and Ringold, grew up along the riverbanks in the early 20th century.

Other ferries were established at Wahluke and Richmond. These towns and nearly all other structures were razed after the U.S. Government acquired the land for the original Hanford Engineer Works in the early 1940s (part of the Manhattan Project). Plutonium produced at the 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 destroyed Nagasaki, Japan, to help end World War II. The Hanford 100 B-Reactor is listed on the National Register and is designated a National Mechanical Engineering Landmark, a National Historic Civil Engineering Landmark, and a National Nuclear Engineering Landmark (DOE 1996a:3-48).

3.2.9.2.2 Proposed Facility Locations

Within the 200 Area, the only National Register–evaluated historic site is the old White Bluffs freight road that crosses diagonally through the 200 West Area. The road, which was originally a Native American trail, has been in continuous use as a transportation route since prehistoric times and has played a role in European-American immigration, regional development, agriculture, and the recent Hanford operations. The road has been determined eligible for inclusion on the National Register by the State Historic Preservation Officer, but the segment in the 200 West Area is considered a noncontributing element (i.e., lacking sufficient integrity to be a significant element of the road). A 100-m (328-ft) restricted zone protects the road from uncontrolled disturbance. Buildings in the 200 Area associated with the Manhattan Project and Cold War era have been evaluated for eligibility for nomination to the National Register and are under review by the State Historic Preservation Officer. No known historic resources have been identified in the 400 Area (DOE 1996b:3-49).

3.2.9.3 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.

3.2.9.3.1 General Site Description

In prehistoric and early historic times, the Hanford Reach was heavily populated by Native Americans of various tribal affiliations. The Wanapum and the Chamnapum bands 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. Palus People, who lived on the lower Snake River, joined the Wanapum and Chamnapum to fish the Hanford Reach, and some inhabited the east bank of the river. Walla Walla and Umatilla People also made periodic visits to fish in the area. These people retain traditional secular and religious ties to the region, and many have knowledge of the ceremonies and lifeways of their culture. The Washani, or Seven Drums religion, which has ancient roots and originated among the Wanapum, is still practiced by many people on the Yakama, Umatilla, Warm Springs, and Nez Perce Reservations. Native plant and animal foods, some of which can be found at Hanford, are used in the ceremonies performed by tribal members (DOE 1996b:4-71).

Consultation is required to identify the traditional cultural properties that are important in maintaining the cultural heritage of Native American tribes. Under separate treaties signed in 1855, the Confederated Tribes and Bands of the Yakama Indian Nation and the Confederated Tribes of the Umatilla Indian Reservation ceded lands to the United States that include the present Hanford Site. Under the treaties, the tribes reserved the right to fish at usual and accustomed places in common with the citizens of the territory, and retained the privilege of hunting, gathering roots and berries, and pasturing horses and cattle upon open, unclaimed land. The Treaty of 1855 with the Nez Perce Tribe includes similar reservations of rights, and the Nez Perce have identified the Hanford Reach as the location of usual and accustomed places for fishing. The Wanapum People are not signatory to any treaty with the United States and are not a federally recognized tribe; however, they live about 8 km (5 mi) west of the

Hanford boundary, they were historical residents of Hanford, and their interests in the area have been acknowledged (DOE 1996b:4-71, 4-72).

All these tribes are active participants in decisions regarding Hanford and have expressed concerns about hunting, fishing, pasture rights, and access to plant and animal communities and important sites. Sites sacred to Native Americans at Hanford include remains of prehistoric villages, burial grounds, 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 (DOE 1996a:3-49).

Consultations (see Chapter 5 and Appendix O) were initiated with appropriate Native American groups to determine any concerns associated with the actions evaluated in this SPD EIS.

3.2.9.3.2 Proposed Facility Locations

Neither the 200 East Area nor the 400 Area is known to contain any Native American resources.

3.2.9.4 Paleontological Resources

Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geological age.

3.2.9.4.1 General Site Description

Remains from the Pliocene and Pleistocene Ages have been identified at Hanford. The Upper Ringold Formation dates to the Late Pliocene Age and contains fish, reptile, amphibian, and mammal fossil remains. Late Pleistocene Touchet beds have yielded mammoth bones. These beds are composed of fluvial sediments deposited along ridge slopes that surround Hanford at distances greater than 5 km (3.1 mi) from the 200 and 400 Areas (DOE 1996a:3-49).

3.2.9.4.2 Proposed Facility Locations

No paleontological resources have been reported near the 200 and 400 Areas.

3.2.10 Land Use and Visual Resources

3.2.10.1 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, cultural, geological, aquatic, and atmospheric).

Hanford covers approximately 1,450 km^2 (560 mi^2) of the southeastern part of the State of Washington and extends over parts of Benton, Grant, and Franklin Counties. The site is owned entirely by the Federal Government and is administered and controlled by DOE (DOE 1996a:3-23).

3.2.10.1.1 General Site Description

The Tri-Cities area southeast of Hanford includes residential, commercial, and industrial land use. This area, encompassing the cities of Richland, Kennewick, and Pasco, is the population center closest to Hanford. Additional cities near the southern boundary of Hanford include Benton City, Prosser, and West Richland (DOE 1996b:4-81). Agriculture is a major land use in the remaining areas surrounding Hanford. In 1996, wheat was the largest crop in terms of area planted in Benton, Franklin, and Grant Counties. Alfalfa, apples, asparagus, cherries, corn, grapes, and potatoes are the other major crops in Benton, Franklin, and Grant Counties (DOE 1996b:4-106). Hanford is a Superfund site, listed on the National Priorities List. Public access to most facility areas is restricted.

DOE has designated the entire Hanford Site as a National Environmental Research Park, an outdoor laboratory for ecological research to study the environmental effects of energy development. The Hanford National Environmental Research Park is a shrub-steppe habitat that contains a wide range of semiarid land ecosystems and offers the opportunity to examine linkages between terrestrial, subsurface, and aquatic environments (DOE 1996a:3-23).

Land-use categories at Hanford include reactor operations, waste operations, administrative support, operations support, sensitive areas (including environmentally or culturally important areas), R&D and engineering development, and undeveloped areas. Generalized land uses at Hanford and vicinity are shown in Figure 3–9. Approximately 6 percent of Hanford has been disturbed and is occupied by operational facilities (DOE 1995b:4-1). Hanford contains a variety of widely dispersed facilities, including old reactors, R&D facilities, and various production and processing plants. The largest category of existing Hanford land use is sensitive areas. Approximately 665 km^2 (257 mi^2), nearly half the site, have been designated as ecological study areas or refuges. Sensitive open-space areas include the Fitzner-Eberhardt Arid Lands Ecology Reserve near Rattlesnake Mountain and two areas north of the Columbia River: the Saddle Mountain National Wildlife Refuge, administered by the USFWS, and the Wahluke Slope Wildlife Recreation Area, managed by the Washington State Department of Fish and Wildlife (DOE 1996b:4-109). Other special-status lands in the vicinity include McNary National Wildlife Refuge, administered by the USFWS, and the Columbia River Islands Area of Critical Environmental Concern and McCoy Canyon, both administered by the Bureau of Land Management (BLM).

The Fitzner-Eberhardt Arid Lands Ecology Reserve, encompassing approximately 315 km^2 (122 mi^2) in the southwestern portion of Hanford, is managed as a habitat and wildlife reserve and environmental research center by the USFWS (DOE 1996b:4-109, Sandberg 1998a). The Rattlesnake Hills Research Natural Area of the Arid Lands Ecology Reserve remains the largest Research Natural Area in the State of Washington. Because public access to the Arid Lands Ecology Reserve has been restricted since 1943, the shrub-steppe habitat is virtually undisturbed. This geographic area contains a number of small, contaminated sites that were remediated in 1994 and 1995 and have been revegetated (DOE 1996b:4-109).

The Columbia River, which is adjacent to and runs through the Hanford Site, is used for public boating, water skiing, fishing, and hunting of upland game birds and migratory fowl. Public access is allowed on certain islands, while other areas are considered sensitive because of unique habitats and the presence of cultural resources (DOE 1996b:4-109). The area known as the Hanford Reach includes the quarter-mile strip of public land on either side of the last free-flowing, nontidal segment of the Columbia River. In 1988, Congress passed Public Law 100-605, known as the *Comprehensive Conservation Study of the Hanford Reach of the Columbia River*, which required the Secretary of the Interior to prepare a study in consultation with the Secretary of Energy to evaluate outstanding features of the Hanford Reach (DOE 1996b:4-109). The results of this study can be found in the *Hanford Reach of the Columbia River Comprehensive River Conservation Study and Environmental Impact Statement* (NPS 1994). The study recommends that Congress designate an 80-km (50-mi) segment of the Columbia River extending downstream from below Priest Rapids Dam to near Johnson Island (river mile 346.5 to river mile 396) as a National Wildlife Refuge and Wild and Scenic River.

About 2,400 ha (5,930 acres) or 1.7 percent of the total acreage at Hanford is available for radioactive waste management facilities (DOE 1997a:4-20). Onsite programmatic and general purpose space totals approximately 799,000 m^2 (8.6 million ft^2). Fifty-one percent or approximately 408,000 m^2 (4.4 million ft^2) is general purpose space, including offices, laboratories, shops, warehouses, and other support facilities. The remaining 392,000 m^2 (4.2 million ft^2) of space is devoted to programmatic facilities, including processing, evaporation, filtration, waste recovery, waste treatment, waste storage facilities, and R&D laboratories (Mecca 1997a:120).

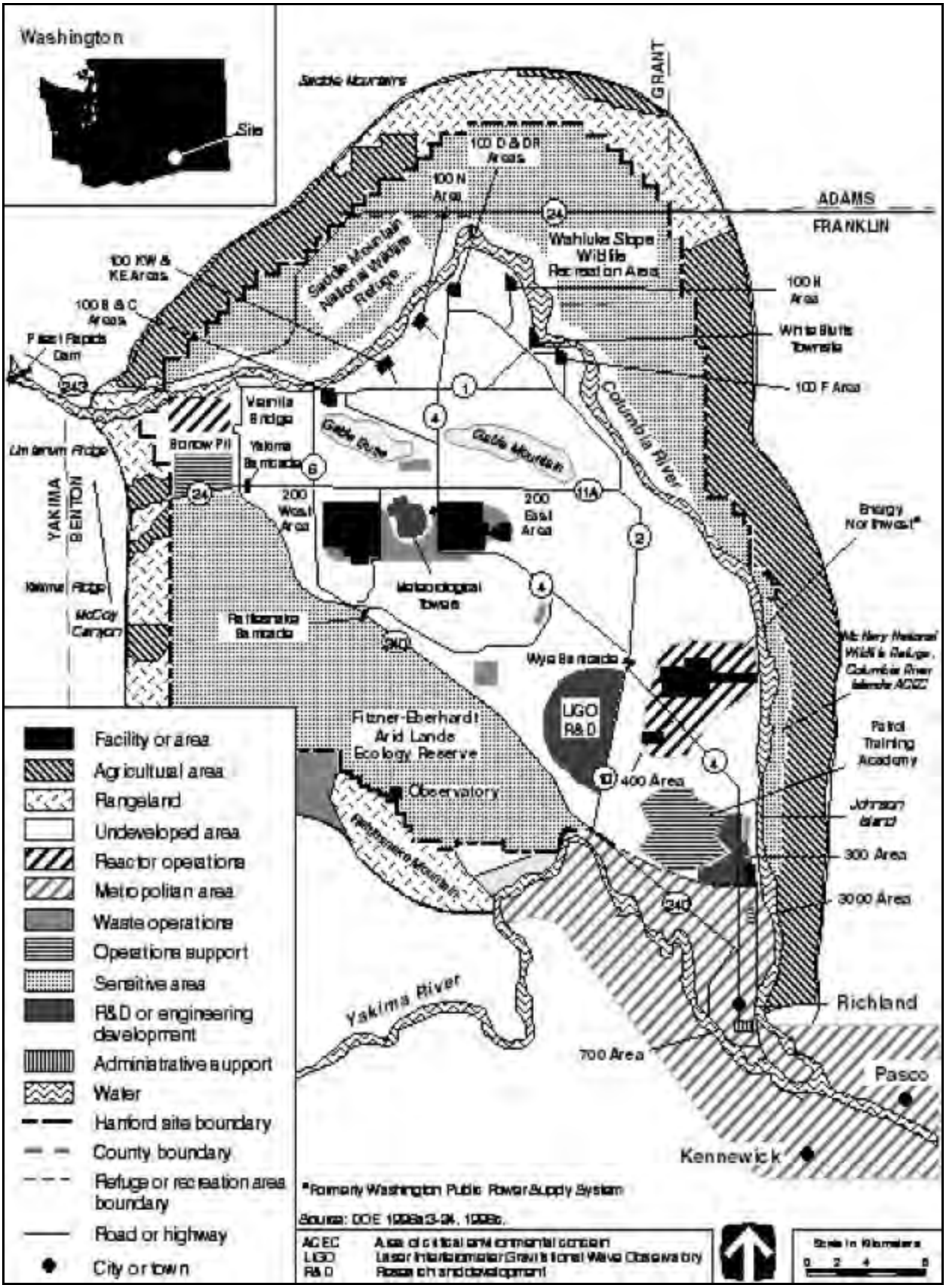


Figure 3–9. Generalized Land Use at Hanford and Vicinity

The 200 East Area is on the Central Plateau. This areas occupies about 11 km^2 (4.2 mi^2) and is dedicated to fuel reprocessing, waste-processing management, and disposal activities. Waste operations and operations support are the primary land uses. The Environmental Restoration Disposal Facility provides disposal capacity for environmental remediation waste generated during remediation of the Hanford Site (DOE 1996b:4-110).

The 400 Area occupies 0.6 km^2 (0.2 mi^2) and is about 8 km (5 mi) northwest of the 300 Area (DOE 1995b:4-2). It is the site of FFTF used in the testing of breeder reactor systems. Also in this area is FMEF, an unused building designed to fabricate fast breeder reactor fuel.

The *Hanford Site Development Plan* provides an overview of land use, infrastructure, and facility requirements to support the DOE missions at Hanford (DOE 1996b:4-109). Included in the plan is a Master Plan section that outlines the relationship of the land and the infrastructure required to support Hanford Site missions (DOE 1996b:4-109). The DOE Richland Operations Office has undertaken new comprehensive land-use planning to define how to best use the land at Hanford for the next 30 to 40 years (DOE 1996a:3-23). Its *Comprehensive Land-Use Plan* identifies existing and planned land uses, with accompanying restrictions; covers a specific timeframe; and will be updated as necessary.

Private lands bordering Hanford are subject to the planning regulations of Benton, Franklin, and Grant Counties and the city of Richland. Most of the land at Hanford is situated in Benton County. Benton County and the city of Richland have a comprehensive land-use planning process under way, with deadlines mandated under the State of Washington Growth Management Act of 1990 (DOE 1996a:3-23).

Under separate treaties signed in 1855, lands occupied by the present Hanford Site were ceded to the United States by the Confederated Tribes and Bands of the Yakama Indian Nation and by the Confederated Tribes of the Umatilla Indian Reservation (DOE 1996b:4-115). Under these treaties, the tribes retained the right to fish in their usual and accustomed places, and to hunt, gather roots and berries, and pasture horses and cattle on open, unclaimed lands. Tribal fishing rights have been recognized as effective within the Hanford Reach. DOE considers Hanford's past nuclear materials production mission and its current mission of waste management inconsistent with the continued exercise of these treaty-reserved privileges (DOE 1996b:4-115, 4-116).

3.2.10.1.2 Proposed Facility Locations

The 200 East Area is on a plateau about 11 km (6.8 mi) from the Columbia River. The 200 East and West Areas cover about 16 km^2 (6.2 mi^2) and have been dedicated for some time to fuel-reprocessing and waste management and disposal activities (DOE 1995b:4-2). Waste operations are confined primarily to the 200 Areas. The 200 East Area had previously been used to reprocess irradiated nuclear fuel and to store the resulting waste (DOE 1996c:4-50). The land is currently disturbed and is designated for waste operations. The distance from the 200 East Area to the nearest site boundary is approximately 10 km (6.2 mi).

The land in the 400 Area is currently disturbed and is designated for reactor operations. The distance from the 400 Area to the nearest site boundary is 7 km (4.3 mi).

3.2.10.2 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.

3.2.10.2.1 General Site Description

Hanford is 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. The topography of land in the vicinity of Hanford ranges from generally flat to gently rolling. Rattlesnake Mountain, rising to 1,060 m (3,480 ft) above mean sea level, forms the southwestern boundary of the site (DOE 1995a:4-33). Gable Mountain and Gable Butte are the highest land forms within the site, rising approximately 60 m (200 ft) and 180 m (590 ft), respectively. The Columbia River flows through the northern part of the site and, turning south, forms part of the eastern site boundary. White Bluffs, steep whitish-brown bluffs adjacent to the Columbia River and above the northern boundary of the river in this region, are a striking feature of the landscape (Neitzel 1996:4.125).

Typical of the regional shrub-steppe desert, the site is dominated by widely spaced, low-brush grasslands. A large area of unvegetated, mobile sand dunes extends along the east boundary, and unvegetated blowouts are scattered throughout the site. Hanford is characterized by mostly undeveloped land, with widely spaced clusters of industrial buildings along the southern and western banks of the Columbia River and at several interior locations.

The adjacent visual landscape consists primarily of rural rangeland and farms; the city of Richland, part of the Tri-Cities area, is the only adjoining urban area. Viewpoints affected by DOE facilities are primarily associated with the public access roadways (including State Routes 24 and 240, Hanford Road, Horn Rapids Road, Route 4 South, and Steven Drive), the bluffs, and the northern edge of the city of Richland. The Energy Northwest (formerly WPPSS) nuclear reactors and DOE facilities are brightly lit at night and are highly visible from many areas. Developed areas are consistent with a Visual Resource Management (VRM) Class IV designation, while the remainder of the Hanford Site ranges from VRM Class III to Class IV (DOI 1986a, 1986b).

Site facilities across Hanford can be seen from elevated locations (e.g., Gable Mountain), a few public roadways (State Routes 24 and 240), and the Columbia River. State Route 24 provides public access to the northern portion of the site. The height of structures ranges from about 3 to 30 m (10 to 100 ft), with a few stacks and towers that reach 60 m (200 ft). Viewsheds along this highway include limited views of the Columbia River where the road drops down into the river valley. A turnout on State Route 24 along the north side of the river offers views of the river and B- and C-Reactors. A rest stop along the road to the south of the river provides views of the Umtanum Ridge to the west, the Saddle Mountains to the north, and the Columbia River valley to the east and west (DOE 1996b:4-96). State Route 240 provides public access to the southwestern portion of the Hanford Site. Viewsheds along this highway include the flat, open lands of the Arid Lands Ecology Reserve in the foreground to the west, with the prominent peaks of Rattlesnake Mountain and the extended ridgelines of the Rattlesnake Hills in the background. From the highway, views are expansive due to the flat terrain, with Saddle Mountain in the distance to the north and steam plumes from the Energy Northwest reactor cooling towers often visible in the distance to the east. Views of DOE facilities from the surface of the Columbia River are generally blocked by high riverbanks; however, steam plumes from the Energy Northwest facility are visible.

3.2.10.2.2 Proposed Facility Locations

Facilities in the 200 East Area are in the interior of the Hanford Site and cannot be seen from the Columbia River or State Route 24. Views to the east from State Route 240 include fairly flat terrain, with the structures of the 200 East and 200 West Areas in the middle ground with Gable Butte and Gable Mountain visible in the background. Developed areas within the 200 East Area are consistent with a VRM Class IV designation. Natural features of visual interest within a 40-km (25-mi) radius include the Columbia River at 10 km (6.2 mi), Gable Butte at 10 km (6.2 mi), Rattlesnake Mountain at 14 km (8.7 mi), and Gable Mountain at 5.3 km (3.3 mi).

FMEF, the tallest building in the 400 Area, is 30 m (100 ft) tall and can be seen from State Route 240. Developed areas within the 400 Area are consistent with a VRM Class IV designation (DOI 1986a, 1986b). Natural features of visual interest within a 40-km (25-mi) radius include the Columbia River at 6.8 km (4.2 mi), Gable Butte at 27 km (17 mi), Rattlesnake Mountain at 17 km (11 mi), and Gable Mountain at 19 km (12 mi) (Mecca 1997a:18).

3.2.11 Infrastructure

Site infrastructure includes those utilities and other resources required to support construction and continued operation of mission-related facilities identified under the various proposed alternatives.

3.2.11.1 General Site Description

Hanford has numerous research, processing, and administrative facilities. An extensive infrastructure system supports these facilities, as shown in Table 3–12.

Table 3–12. Hanford Sitewide Infrastructure Characteristics

Resource	Current Usage	Site Capacity
Transportation		
Roads (km)	420	420
Railroads (km)	204[a]	204[a]
Electricity		
Energy consumption (MWh/yr)	323,128	2,484,336
Peak load (MW)	60.7	283.6
Fuel		
Natural gas (m^3/yr)	459,200	20,804,000
Oil (l/yr)	9,334,800	14,775,000[b]
Coal (t/yr)	NA[c]	NA[c]
Water (l/yr)	2,754,000,000	8,263,000,000

[a] DOE is in the process of discontinuing rail service to most of Hanford (see Section 3.2.11.1.1).

[b] As supplies get low, more can be supplied by truck or rail.

[c] See Section 3.2.1.1.1.

Key: NA, not applicable.

Source: Teal 1997:4.

3.2.11.1.1 Transportation

Hanford has a network of paved roads, with 104 km (65 mi) of the 420 km (261 mi) of these roads accessible to the public. The site is crossed by State Route 240, which is the main route traveled by the public. Most onsite employees travel Route 4, the primary highway from the Tri-Cities area to most Hanford outer 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 Rattlesnake barricades (DOE 1996a:3-26; Mecca 1997a:126).

Onsite rail transport to Hanford is provided by a short-line railroad. 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 (DOE 1996a:3-26; Mecca 1997a:126). The site railroad is in transition from DOE ownership to the Port of Benton with a planned date of October 1, 1998. At that time only the southern portion of the rail

line that is connected to and serviced by Union Pacific would be transferred. It is expected that the Port of Benton will also have track rights as far north as the Energy Northwest (formerly WPPSS) reactors. By September 30, 1998, DOE rail operations will be discontinued. There are no current plans for service north of the Energy Northwest reactor site (Sandberg 1998a).

3.2.11.1.2 Electricity

Most site electric power is purchased from the Bonneville Power Administration and routed through substations and switching stations in a manner that provides supply redundancy on the electrical transmission and distribution systems. Bonneville Power Administration electric power is provided to three distinct systems on the Hanford Site, the 100/200 Area System, the 300 Area System, and the 400 Area System (Mecca 1997a:137). Power for the 700, 1100, and 3000 Areas is provided by the city of Richland (DOE 1996b:4-93).

3.2.11.1.3 Fuel

Natural gas, provided by the Cascade Natural Gas Corporation, is used in a few locations at Hanford. Fuel oil and propane are also used in some areas. Oil capacity is only limited by the number of deliveries by truck (DOE 1996a:3-27).

3.2.11.1.4 Water

The Columbia River is the primary source of raw water for Hanford. Average annual river flow through the site is approximately 203 million l/min (54 million gal/min) (Mecca 1997a:126). The Export Water System supplies raw river water to the 100-B, 100-D, 200 East, 200 West, and 251-W potable water filtration and treatment systems. Daily pumping averages about 72 million l/day (19 million gal/day) (Rohl 1994:2-2). Wells supply water to the 400 Area and a variety of low-use facilities at remote locations (Mecca 1997a:126).

3.2.11.1.5 Site Safety Services

The Hanford fire department operates four fire stations within the Hanford Site. The stations are strategically located to ensure minimum response time to all facilities. The fire department also provides the site with ambulance, emergency medical technicians, and advanced first aid-certified firefighters (Mecca 1997a:154).

3.2.11.2 Proposed Facility Locations

A summary of the infrastructure characteristics of the 200 East Area and the 400 Area's FMEF is shown in Table 3–13.

Table 3–13. Hanford Infrastructure Characteristics for 200 East Area and FMEF

	200 East Area		FMEF	
Resource	**Current Usage**	**Capacity**	**Current Usage**	**Capacity**
Electricity				
Energy consumption (MWh/yr)	66,671	345,000	7,300	61,000
Peak load (MW)	16.6	40.0	4.1	26.6
Fuel				
Natural gas (m^3/yr)	NA	NA	NA	NA
Oil (l/yr)	7,294,220[a]	NA[b]	760	18,900[b]
Coal (t/yr)	NA	NA	NA	NA
Water (l/yr)	688,600,000	2,596,000,000	41,690,000	397,950,000

[a] See Sandberg 1998c.

[b] As supplies get low, more can be supplied by truck or rail.

Key: FMEF, Fuels and Materials Examination Facility; NA, not applicable.

Source: Teal 1997:4.

3.2.11.2.1 Electricity

Power to the 100/200 Area electrical system is provided from two sources, the Bonneville Power Administration Midway substation at the northwestern site boundary, and a transmission line from the Bonneville Power Administration Ashe substation. The 100/200 Area electrical system consists of about 80 km (50 mi) of 230-kV transmission lines, six primary substations, about 217 km (135 mi) of 13.8-kV distribution lines, and 124 secondary substations. The 100/200 Area transmission and distribution systems, as with the Bonneville Power Administration source lines, have redundant routings to ensure electrical service to individual areas and designated facilities within those areas (Mecca 1997a:137). The substation providing power to the 200 Area has a peak load capacity of 40 MW (Teal 1997:4).

Primary electric power to the 400 Area is provided by two 115-kV Bonneville Power Administration transmission lines, one from the Bonneville Power Administration Benton substation and the second from the Bonneville Power Administration White Bluffs substation. There is one 13.8-kV tie line from the 300 Area to the 400 Area emergency power system that also provides alternate power for maintenance outages. Redundancy in the distribution lines to designated facilities ensures continuity of service and rerouting of power for maintenance of system components. The approximate lengths of distribution lines in the 400 Area are as follows: 13.8-kV lines, 7.3 km (4.5 mi); 2.4-kV lines, 518 m (1,700 ft); and 480-V lines, 14.6 km (9.1 mi). There are two substations in the 400 Area: 451A, which serves FFTF reactor and associated buildings, and 451B, which serves FMEF and associated buildings (Mecca 1997a:168, 169). The peak load capacity for FMEF is 26.6 MW and the current usage is 4.1 MW (Teal 1997:4).

3.2.11.2.2 Fuel

Coal-fire steam generation facilities have been shut down at Hanford. The conversion to oil-fired sources was completed in 1998 (see Section 3.2.1.1.1). Fuel usage at 200 Area would be about 7,294,220 l/yr (1,926,935 gal/yr) (Sandberg 1998c). Fuel usage and capacity at FMEF are 760 l/yr (201 gal/yr) and 18,900 l/yr (4,993 gal/yr), respectively (Teal 1997:4).

3.2.11.2.3 Water

The 200 East Area is the major consumer of raw water delivered via the Export Water System. That water is received at the 11.4-million-l (3-million-gal) 282-E Reservoir at a capacity of 9,842 l/min (2,600 gal/min). Monthly average potable water flow in the 200 East Area ranges between 3,028 and 3,312 l/min (800 and 875 gal/min). Daily average flow can vary widely, depending primarily on area activity (Rohl 1994:2-5, 2-6).

The 400 Area receives water from three underground deep-water wells. Each of these wells has a pumping capacity of 833 l/min (220 gal/min). Water is pumped to three aboveground storage tanks that have a combined capacity of 3,028,320 l (800,000 gal). The observed flow ranges from 681 l/min (180 gal/min) during the summer months to 284 l/min (75 gal/min) during the winter months (Rohl 1994:2-7).

3-hr averaging, 10 Fg/m^3 for 24-hr averaging, and 2.1 Fg/m^3 for the annual average; and an annual average total suspended particulate concentration of 15 Fg/m^3 (Abbott, Crockett, and Moor 1997:7). Measured concentrations attributable to INEEL are in compliance with applicable guidelines and regulations. Additional information on ambient air quality at INEEL and detailed information on emissions of other pollutants at INEEL are provided in the *INEEL Site Environmental Report for 1995* (Mitchell, Peterson, and Hoff 1996:6-4–6-6).

3.3.1.1.2 Proposed Facility Location

The meteorological conditions for INEEL are considered to be representative of the INTEC area. Primary sources of pollutants at INTEC include the New Waste Calcining Facility and coal-fired steam-generating facilities (Mitchell, Peterson, and Hoff 1996:6-4, 6-5). These facilities are sources of carbon monoxide, nitrogen dioxide, sulfur dioxide, and PM_{10}. The Waste Calcining Facility is a large source of nitrogen dioxide at INEEL.

3.3.1.2 Noise

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.

3.3.1.2.1 General Site Description

Major noise emission sources within INEEL include various industrial facilities, equipment, and machines (e.g., cooling systems, transformers, engines, pumps, boilers, steam vents, paging systems, construction and materials-handling equipment, and vehicles). Most INEEL industrial facilities are far enough from the site boundary that noise levels at the boundary would not be measurable or would be barely distinguishable from background levels (DOE 1996a:3-112).

Existing INEEL-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. Route 20 about 15 m (50 ft) from the roadway indicate that the sound levels from traffic range from 64 to 86 dBA and that the primary source is buses (71 to 80 dBA) (Abbott, Brooks, and Martin 1991:64). While few people reside within 15 m (50 ft) of the roadway, the results indicate that INEEL traffic noise might be objectionable to members of the public residing near principal highways or busy bus routes. Noise levels along these routes may have decreased somewhat due to reductions in employment and bus service at INEEL in the last few years. The acoustic environment along the INEEL site boundary in rural areas and at nearby areas away from traffic noise is typical of a rural location: the average day-night average sound level is in the range of 35 to 50 dBA (EPA 1974:B-4). Except for the prohibition of nuisance noise, neither the State of Idaho nor local governments have established any regulations that specify acceptable community noise levels applicable to INEEL (DOE 1996a:F-32).

The EPA guidelines for environmental noise protection recommend an average day-night average sound level of 55 dBA as sufficient to protect the public from the effects of broadband environmental noise in typically quiet outdoor and residential areas (EPA 1974:29). Land-use compatibility guidelines adopted by the Federal Aviation Administration and the Federal Interagency Committee on Urban Noise indicate that yearly day-night average sound levels less than 65 dBA are compatible with residential land uses and levels up to 75 dBA are compatible with residential uses if suitable noise reduction features are incorporated into structures (DOT 1995). It is expected that for most residences near INEEL, the day-night average sound levels are compatible with the residential land use, although for some residences along major roadways noise levels may be higher than 65 dBA.

3.3.1.2.2 Proposed Facility Location

No distinguishing noise characteristics have been identified at the INTEC area. INTEC is far enough—about 12 km (7.5 mi)—from the site boundary that noise levels from the facilities are not measurable or are barely distinguishable from background levels.

3.3.2 Waste Management

Waste management includes minimization, characterization, treatment, storage, transportation, and disposal of waste generated from ongoing DOE 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.

3.3.2.1 Waste Inventories and Activities

INEEL manages the following types of waste: HLW, TRU, mixed TRU, LLW, mixed LLW, hazardous, and nonhazardous. HLW would not be generated by surplus plutonium disposition activities at INEEL, and therefore, will not be discussed further. Waste generation rates and the inventory of stored waste from activities at INEEL are provided in Table 3–16. Table 3–17 summarizes the INEEL waste management capabilities. More detailed descriptions of the waste management system capabilities at INEEL are included in the *Storage and Disposition PEIS* (DOE 1996a:3-141–145, E-33–E-48) and the *Programmatic Spent Nuclear Fuel Management and Idaho National Engineering Laboratory Environmental Restoration and Waste Management Programs Final Environmental Impact Statement* (DOE 1995b:2.2-30).

Table 3–16. Waste Generation Rates and Inventories at INEEL

Waste Type	Generation Rate (m^3/yr)	Inventory (m^3)
TRU[a]		
Contact handled	0	39,300
Remotely handled	0	200
LLW	2,624	18,634
Mixed LLW		
RCRA	180	25,734
TSCA	<1	2
Hazardous	835[b]	NA[c]
Nonhazardous		
Liquid	2,000,000[d]	NA[c]
Solid	62,000	NA[c]

[a] Includes mixed TRU waste.

[b] Includes 760 m^3 that is recyclable.

[c] Generally, hazardous and nonhazardous wastes are not held in long-term storage.

[d] Projected annual average generation for 1997–2006.

Key: LLW, low-level waste; NA, not applicable; RCRA, Resource Conservation and Recovery Act; TRU, transuranic; TSCA, Toxic Substances Control Act.

Source: DOE 1996d:15, 16, except hazardous and nonhazardous solid waste (DOE 1996a:3-142, 3-143) and nonhazardous liquid waste (Werner 1997).

EPA placed INEEL on the National Priorities List on December 21, 1989. In accordance with CERCLA, DOE entered into a consent order with EPA and the State of Idaho to coordinate cleanup activities at INEEL under one comprehensive strategy. This agreement integrates DOE's CERCLA response obligations with RCRA

corrective action obligations. 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 INEEL to support delisting from the National Priorities List by 2019 (DOE 1996a:3-141). More information on regulatory requirements for waste disposal is provided in Chapter 5.

Table 3–17. Waste Management Capabilities at INEEL

			Applicable Waste Type					
Facility Name/Description	**Capacity**	**Status**	**TRU**	**Mixed TRU**	**LLW**	**Mixed LLW**	**Haz**	**Non-Haz**
Treatment Facility (m^3/yr except as otherwise specified)								
INTEC HEPA Filter Leach, m^3/day	0.21	Online		X		X		
INTEC Debris Treatment and Containment, m^3/day	88	Part B permit pending		X		X		
Advanced Mixed Waste Treatment Project	6,500	Planned for 2003		X		X		
[Text deleted.]								
ANL–W Remote Treatment Facility	42	Planned for 2000	X	X	X	X		
ANL–W HFEF Waste Characterization Area	37	Online	X	X				
INTEC Waste Immobilization Facility	48	Planned for 2020		X	X	X		
INTEC Liquid Effluent Treatment and Disposal Facility	11,365	Online				X		
INTEC HLW Evaporator	6,138	Online		X	X	X		
INTEC Process Equipment Waste Evaporator	13,000	Online		X	X	X		
ANL–W Sodium Processing Facility	698	Online				X		
Test Area North Cask Dismantlement	11	Online				X		
WROC - Debris Sizing, kg/hr	1,149	Planned for 2000			X	X		
WROC - Macroencapsulation, kg/hr	2,257	Planned for 1999				X		
WROC - Stabilization, m^3/day	7.6	Online				X		
WERF	49,610	Online			X	X	X	
INTEC Cold Waste Handling Facility	3,700	Online						X
INTEC Sewage Treatment Plant	3,200,000	Online						X
Storage Facility (m^3)								
ANL–W Radioactive Sodium Storage	75	Online		X		X		
ANL–W Sodium Components Maintenance Shop	200	Online				X		
ANL–W Radioactive Scrap and Waste Storage	193	Online	X	X	X	X		

Facility Name/Description	Capacity	Status	Applicable Waste Type					
			TRU	Mixed TRU	LLW	Mixed LLW	Haz	Non-Haz
ANL–W EBR II Sodium Boiler Drain Tank	64	Online				X		
ANL–W HFEF Waste Characterization Area	37	Online	X	X				
INTEC Tank Farm	12,533	Online		X		X		

Table 3–17. Waste Management Capabilities at INEEL (Continued)

Facility Name/Description	Capacity	Status	Applicable Waste Type					
			TRU	Mixed TRU	LLW	Mixed LLW	Haz	Non-Haz
INTEC FDP HEPA Storage	25	Online		X		X		
INTEC NWCF HEPA Storage	56	Online		X		X		
INTEC CPP-1619 Storage	45	Online				X	X	
INTEC CPP-1617 Staging	8,523	Online				X	X	
[Text deleted.]								
RWMC Storage Area-1, 2, and R	64,900	Online	X	X	X[a]	X[a]		
RWMC Waste Storage	112,400	Online	X	X	X[a]	X[a]		
RWMC Intermediate-Level Storage	100	Online	X					
[Text deleted.]								
WROC PBF Mixed LLW Storage	129	Online				X	X	
Portable Storage at SPERT IV	237	Online				X	X	
PBF WERF Waste Storage Building	685	Online				X	X	
Test Area North 647 Waste Storage	104	Online				X	X	
Test Area North 628 SMC Container Storage	125	Online				X	X	
Disposal Facility(m^3/yr)								
RWMC Disposal Facility	37,700	Online			X			
CFA Landfill Complex	48,000	Online						X
Percolation Ponds	2,000,000	Online						X

[a] Waste with alpha contamination greater than 10 but less than 100 nCi/g.

Key: ANL–W, Argonne National Laboratory–West; CFA, Central Facilities Area; CPP, Chemical Processing Plant; EBR, Experimental Breeder Reactor; FDP, Fluorinel Dissolution Process; Haz, hazardous; HEPA, high-efficiency particulate air; HFEF, Hot Fuel Examination Facility; HLW, high-level waste; INTEC, Idaho Nuclear Technology and Engineering Center; LLW, low-level waste; NWCF, New Waste Calcining Facility; PBF, Power Burst Facility; RWMC, Radioactive Waste Management Complex; SMC, Specific Manufacturing Complex; SPERT, Special Power Excursion Reactor Test; TRU, transuranic; WERF, Waste Experimental Reduction Facility; WROC, Waste Reduction Operations Complex.

Source: Abbott 1998; Abbott, Crockett, and Moor 1997:20; Depperschmidt 1999; Moor 1998; Werner 1997.

3.3.2.2 Transuranic and Mixed Transuranic Waste

TRU waste generated since 1972 is segregated into contact-handled and remotely handled categories and stored at the Radioactive Waste Management Complex in a form designed for eventual retrieval (DOE 1996a:3-144). Some TRU waste is also stored at the Radioactive Scrap and Waste Facility at ANL–W (DOE 1995b:2.2-36). There is very little TRU waste generated at INEEL. Most of the TRU waste in storage was received from the Rocky Flats Environmental Technology Site (DOE 1996a:3-144). TRU waste will be treated to meet WIPP waste acceptance criteria, packaged in accordance with DOE and DOT requirements, and transported to WIPP

for disposal (DOE 1996a:3-144). The first shipment of TRU waste to WIPP was made in April 1999 (DOE 1999c).

The existing treatment facilities for TRU waste at INEEL are limited to testing, characterization, and repackaging. The planned Waste Characterization Facility will characterize TRU waste and either reclassify it (if it is found to be LLW) for disposal on the site, or prepare it so that it meets WIPP waste acceptance criteria (DOE 1996a:E-35).

The Advanced Mixed Waste Treatment Project will be a private sector treatment facility. This facility shall (1) treat waste to meet WIPP waste acceptance criteria, RCRA Land Disposal Restrictions (LDR), and required Toxic Substances Control Act standards; (2) reduce waste volume and life-cycle cost to DOE; and (3) perform tasks in a safe and environmentally compliant manner (Mitchell, Peterson, and Hoff 1996:3-16). Construction of a mixed LLW Disposal Facility and Plasma Hearth Treatment Facility are being considered to support commercial treatment of mixed TRU waste and alpha-contaminated mixed LLW subject to funding restraints and additional NEPA review (DOE 1996a:E-35).

Waste containing between 10 and 100 nCi/g of transuranic radionuclides is called alpha LLW. Although this waste is technically considered LLW rather than TRU waste, it cannot be disposed of at INEEL because it does not meet all INEEL LLW disposal facility acceptance criteria. Alpha LLW and alpha mixed LLW are managed together as part of the TRU waste program. It is expected that these wastes will be treated by the Advanced Mixed Waste Treatment Project and then disposed of at WIPP (DOE 1995b:2.2-34, 2.2-35).

3.3.2.3 Low-Level Waste

Liquid LLW is either evaporated and processed to calcine or solidified before disposal (DOE 1996a:E-35). INTEC has the capability to treat aqueous LLW. Liquid LLW is concentrated at the INTEC process equipment waste evaporator, with the condensed vapor processed by the Liquid Effluent Treatment and Disposal Facility. The concentrated materials remaining after evaporation are pumped to the INTEC tank farm (DOE 1995b:2.2-39). Some small volumes of liquid LLW are solidified at the Waste Experimental Reduction Facility for disposal at the Radioactive Waste Management Complex. In addition, small volumes of aqueous LLW are discharged to the double-lined pond at the Test Reactor Area for evaporation (DOE 1995b:2.2-39).

Most solid LLW at INEEL is sent to the Waste Experimental Reduction Facility for treatment by incineration, compaction, size reduction, or stabilization before shipment for disposal at the Radioactive Waste Management Complex or offsite disposal facilities (Werner 1997). Disposal occurs in pits and concrete-lined soil vaults in the subsurface disposal area of the Radioactive Waste Management Complex (DOE 1995b:2.2-39). About 40 percent of the LLW generated at INEEL (that contain less than 10 nCi/g of radioactivity) is buried in shallow trenches; the remaining 60 percent at the Radioactive Waste Management Complex following treatment for volume reduction. Additionally, some LLW is shipped off the site to be incinerated, and the residual ash is returned to INEEL for disposal. The Radioactive Waste Management Complex is expected to be filled to capacity by the year 2030 (Mitchell, Peterson, and Hoff 1996:3-26), although some proposals would close the LLW Disposal Facility by 2006 (DOE 1998d:B-4).

3.3.2.4 Mixed Low-Level Waste

Mixed LLW is divided into two categories for management purposes: alpha mixed LLW and beta-gamma mixed LLW. Most of the alpha mixed LLW stored at INEEL is waste that has been reclassified from mixed TRU waste and is managed as part of the TRU waste program. Therefore, this section deals only with beta-gamma mixed LLW (DOE 1995b:2.2-39, 2.2-40).

Mixed LLW, including polychlorinated biphenyls–contaminated LLW, is stored in several onsite areas awaiting the development of treatment methods (DOE 1996a:3-144). Mixed LLW is stored at the Mixed Waste Storage Facility (or Waste Experimental Reduction Facility Waste Storage Building) and portable storage units at the Power Burst Facility area. In addition, smaller quantities of mixed LLW are stored in various facilities at INEEL including the Hazardous Chemical/Radioactive Waste Facility at INTEC, and the Radioactive Sodium Storage Facility and Radioactive Scrap and Waste Storage Facility at ANL–W (DOE 1995b:2.2-41). Although mixed wastes are stored in many locations at INEEL, the bulk of that volume is solid waste stored at the Radioactive Waste Management Complex (DOE 1996a:E-39).

Aqueous mixed LLW is concentrated at INTEC. The condensate from the waste evaporator is then processed by the Liquid Effluent Treatment and Disposal Facility. The concentrated material remaining after evaporation (mixed LLW) is pumped to the INTEC tank farm for storage (DOE 1995a:2.2-42, 2.2-43).

As part of the site treatment plans required by the FFCA, preferred treatment options have been identified to eliminate the hazardous waste component for many types of mixed LLW (DOE 1995b:2.2-42). Mixed LLW is or will be processed to RCRA LDR treatment standards through several treatment facilities. Those treatment facilities and operational status are: (1) Waste Experimental Reduction Facility Incinerator (operational), (2) Waste Experimental Reduction Facility Stabilization (operational), (3) Test Area North cask dismantlement (operational), (4) Sodium Process Facility (operational), (5) High-Efficiency Particulate Air (HEPA) Filter Leach (operational), (6) Waste Reductions Operations Complex Macroencapsulation (October 1999), (7) Waste Reduction Operations Complex Mercury Retort (March 2000), (8) Debris Treatment (September 2000), and (9) Advanced Mixed Waste Treatment Project (March 2003). Commercial treatment facilities are also being considered, as appropriate (Werner 1997). Currently, limited amounts of mixed LLW are disposed of at Envirocare of Utah (Werner 1997).

3.3.2.5 Hazardous Waste

About 1 percent of the total waste generated at INEEL is hazardous waste. Most of the hazardous waste generated annually at INEEL is transported off the site for treatment and disposal (DOE 1995b:2.2-45). Offsite shipments are surveyed to determine that the wastes have no radioactive content (are not mixed waste) (DOE 1996a:3-145). Highly reactive or unstable materials, such as waste explosives, are addressed on a case-by-case basis and are either stored, burned, or detonated as appropriate (DOE 1995b:2.2-46).

3.3.2.6 Nonhazardous Waste

More than 94 percent of the waste generated at INEEL is classified as industrial waste and is disposed of on the site in a landfill complex in the Central Facilities Area and at the Bonneville County landfill (DOE 1995b:2.2-47). The onsite landfill complex contains separate areas for petroleum-contaminated media, industrial waste, and asbestos waste (Werner 1997). The onsite landfill is 4.8 ha (12 acres) and is being expanded by 91 ha (225 acres) to provide capacity for at least 30 years (DOE 1996a:3-145).

The Cold Waste Handling Facility was recently put into operation at INTEC. This system allows increased volumes of nonhazardous waste to be inspected, recycled, shredded, compacted, and segregated, thereby reducing the amount of material sent to disposal (Mitchell, Peterson, and Hoff 1996:3-24).

Sewage is disposed of in surface impoundments in accordance with terms of the October 7, 1992, consent order. Waste in the impoundments is allowed to evaporate; the resulting sludge is placed in the landfill. Solids are separated and reclaimed where possible (DOE 1996a:3-145). Nonhazardous service wastewater generated at INTEC is disposed to percolation ponds at a flow rate of 3.8 million to 7.6 million l/day (1 million to 2 million gal/day) (Werner 1997). The INTEC sanitary sewer system collects and transfers sanitary waste to

the sewage treatment lagoons east of INTEC for treatment and disposal. This system has a capacity of 3,200,000 m^3/yr (4,190,000 yd^3/yr) (Abbott, Crockett, and Moor 1997:20).

3.3.2.7 Waste Minimization

The DOE Idaho Operations Office has an active waste minimization and pollution prevention program to reduce the total amount of waste generated and disposed of at INEEL. This is accomplished by eliminating waste through source reduction or material substitution; by recycling potential waste materials that cannot be minimized or eliminated; and by treating all waste that is generated to reduce its volume, toxicity, or mobility prior to storage or disposal. The DOE Idaho Operations Office published its first waste minimization plan in 1990, which defined specific goals, methodology, responsibility, and achievements of programs and organizations. The achievements and progress have been updated at least annually (DOE 1996a:E-33).

The INEEL waste minimization program has significantly reduced the quantities of hazardous waste generated at INEEL. For example, in 1992, 760 m^3 (994 yd^3) of hazardous waste was recycled. Recyclable hazardous materials include metals (such as bulk lead, mercury, chromium), solvents, fuel, and other waste materials (DOE 1995b:2.2-45). Soon the use of nonhazardous chemicals and the recycling of those for which there is no substitute should nearly eliminate the generation of hazardous waste (DOE 1996a:E-39).

Another goal of the INEEL waste minimization program is to reduce nonhazardous waste generation by 50 percent over the next 5 years (DOE 1996a:3-145). During 1993–1995, INEEL recycled more than 680,400 kg (1.5 million lb) of paper and cardboard (Mitchell, Peterson, and Hoff 1996:3-26). Efforts are also under way to expand the recycling program to include asphalt and metals and to convert scrap wood into mulch (DOE 1995b:2.2-48).

3.3.2.8 Preferred Alternatives From the WM PEIS

Preferred alternatives from the WM PEIS (DOE 1997a:summary, 97) are shown in Table 3–18 for the four waste types analyzed in this SPD EIS. A decision on the future management of these wastes could result in the construction of new waste management facilities at INEEL and the closure of other facilities. Decisions on the various waste types are expected to be announced in a series of RODs to be issued on this WM PEIS. In fact, the TRU waste ROD was issued on January 20, 1998 (DOE 1998a), with the hazardous waste ROD issued on August 5, 1998 (DOE 1998b). The TRU waste ROD states that DOE will develop and operate mobile and fixed facilities to characterize and prepare TRU waste for disposal at WIPP. Each DOE site that has, or will generate, TRU waste will, as needed, prepare and store its TRU waste on the site. The hazardous waste ROD states that most DOE sites will continue to use offsite facilities for the treatment and disposal of major portions of the nonwastewater hazardous waste, with ORR and SRS continuing to treat some of their own hazardous waste on the site in existing facilities where this is economically favorable. More detailed information and DOE's alternatives for the future configuration of waste management facilities at INEEL is presented in the WM PEIS, and the hazardous waste and TRU waste RODs.

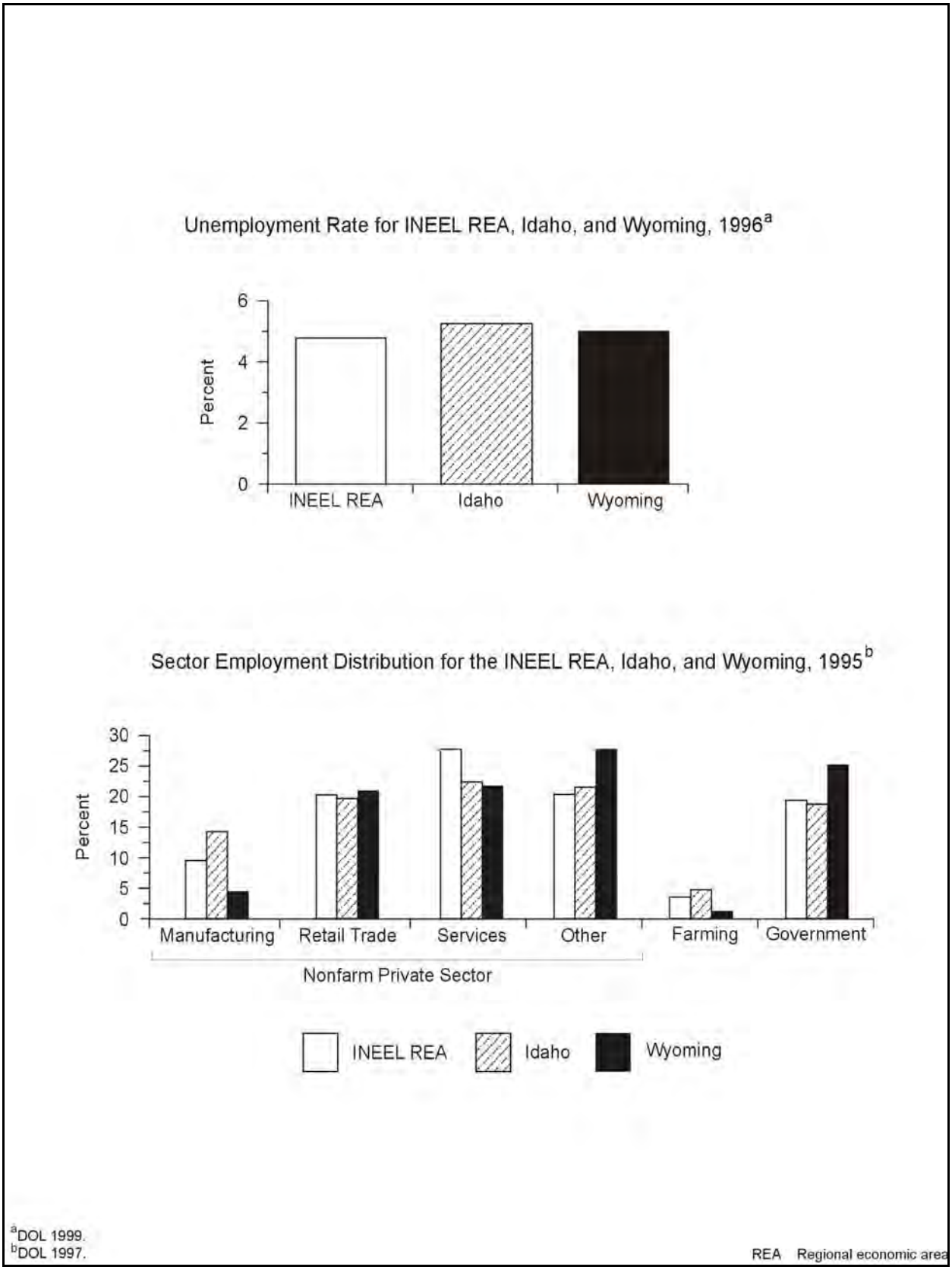
3.3.3 Socioeconomics

Statistics for employment and regional economy are presented for the REA as defined in Appendix F.9, which encompasses 13 counties around INEEL located in Idaho and Wyoming. Statistics for population, housing, community services, and local transportation are presented for the ROI, a four-county area (in Idaho) in which 94.4 percent of all INEEL employees reside as shown in Table 3–19. In 1997, INEEL employed 8,291 persons (about 5.5 percent of the REA civilian labor force) (Werner 1997).

3.3.3.1 Regional Economic Characteristics

Selected employment and regional economy statistics for the INEEL REA, Idaho, and Wyoming are summarized in Figure 3–10. Between 1990 and 1996, the civilian labor force in the REA increased 26 percent to the 1996 level of 150,403. In 1996, the annual unemployment average in the REA was 4.8 percent, which was slightly less than the annual unemployment average for Idaho (5.2 percent) and Wyoming (5 percent) (DOL 1999).

In 1995, service activities represented the largest sector of employment in the REA (27.1 percent). This was followed by retail trade (20.4 percent), and government (19.5 percent). The totals for these employment sectors



[a]DOL 1999.
[b]DOL 1997.

REA Regional economic area

Figure 3–10. Employment and Local Economy for the INEEL Regional Economic Area and the States of Idaho and Wyoming

Table 3–18. Preferred Alternatives From the WM PEIS

Waste Type	Preferred Action
TRU and mixed TRU	DOE prefers the regionalized alternative for treatment and storage of INEEL's TRU waste. Under this alternative, some TRU waste could be received from RFETS for treatment.[a]
LLW	DOE prefers to treat INEEL's LLW on the site. INEEL could be selected as one of the regional disposal sites for LLW.
Mixed LLW	DOE prefers regionalized treatment at INEEL. This includes the onsite treatment of INEEL's wastes and could include treatment of some mixed LLW generated at other sites. INEEL could be selected as one of the regional disposal sites for mixed LLW.
Hazardous	DOE prefers to continue to use commercial facilities for hazardous waste treatment.[b]

[a] ROD for TRU waste (DOE 1998a) states that "each of the Department's sites that currently has or will generate TRU waste will prepare and store its TRU waste on site. . . ."

[b] ROD for hazardous waste (DOE 1998b) selected the preferred alternative at INEEL.

Key: LLW, low-level waste; RFETS, Rocky Flats Environmental Technology Site; TRU, transuranic.

Source: DOE 1997a:summary, 97.

Table 3–19. Distribution of Employees by Place of Residence in the INEEL Region of Influence, 1997

County	Number of Employees	Total Site Employment (Percent)
Bonneville	5,553	67
Bingham	1,077	13
Bannock	615	7.4
Jefferson	583	7
ROI total	7,828	94.4

Source: Werner 1997.

in Idaho were 21.5 percent, 19.6 percent, and 18.7 percent, respectively. The totals for these employment sectors in Wyoming were 21.1 percent, 20.8 percent, and 25 percent, respectively (DOL 1997).

3.3.3.2 Population and Housing

In 1996, the ROI population totaled 213,547. Between 1990 and 1996, the ROI population increased by 10.6 percent, compared with an 17.5 percent increase in Idaho's population (DOC 1997). Between 1980 and 1990, the number of housing units in the ROI increased by 6.7 percent, compared with the 10.2 percent increase in Idaho. The total number of housing units in the ROI for 1990 was 69,760 (DOC 1994). The 1990 ROI homeowner vacancy rate was 2.1 percent compared with the Idaho's rate of 2.0 percent. The ROI renter vacancy rate was 8.3 percent compared with the Idaho's rate of 7.3 percent (DOC 1990a). Population and housing trends are displayed in Figure 3–11.

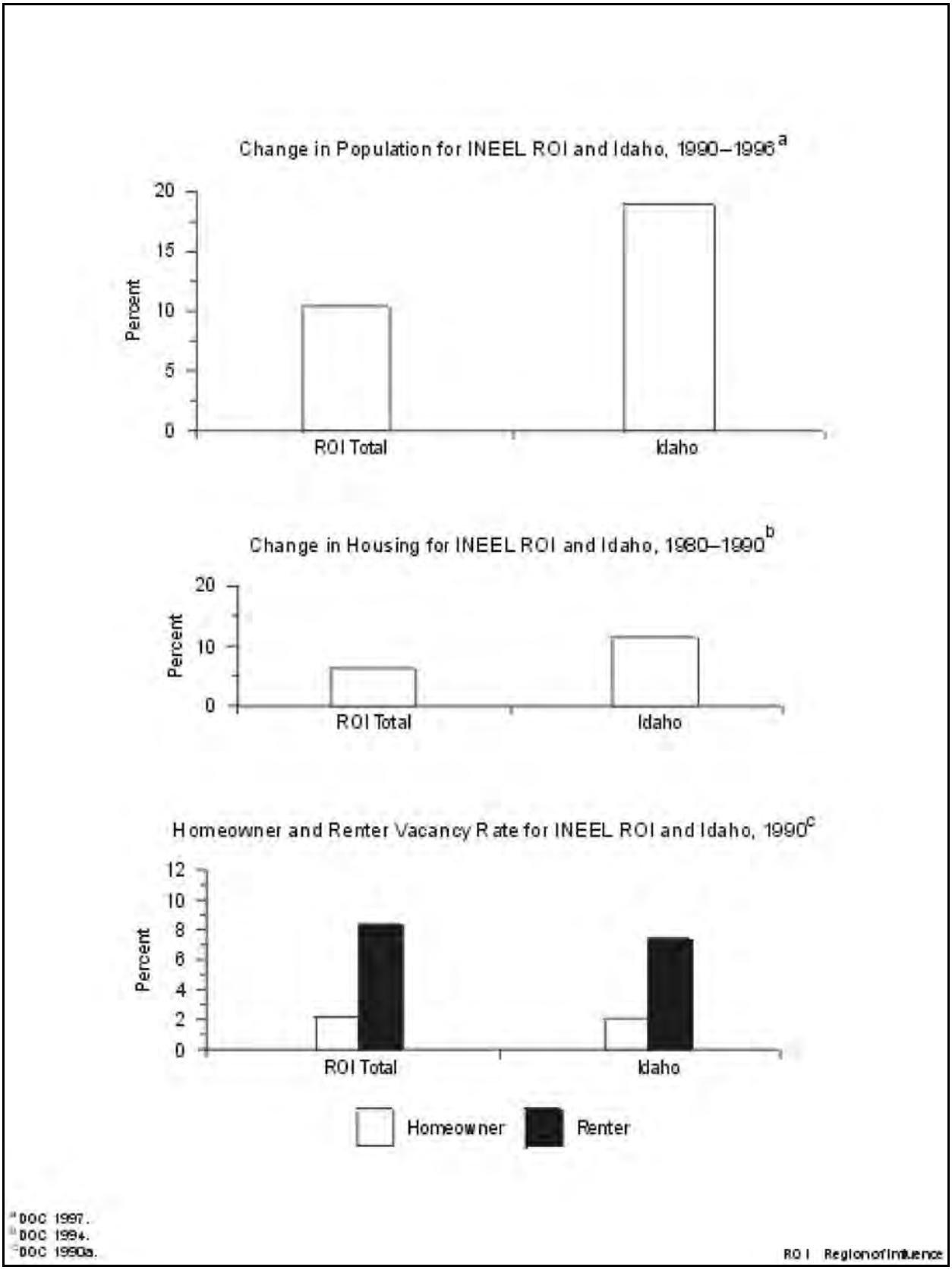


Figure 3–11. Population and Housing for the INEEL Region of Influence and the State of Idaho

3.3.3.3 Community Services

3.3.3.3.1 Education

Thirteen school districts provide public education services and facilities in the INEEL ROI. As shown in Figure 3–12, they operated at between 50 percent (Swan Valley District) and 100 percent (Shelley District) capacity in 1997. In 1997, the average student-to-teacher ratio for the INEEL ROI was 18.8:1 (Nemeth 1997a). In 1990, the average student-to-teacher ratio for Idaho was 12.8:1 (DOC 1990b, 1994).

3.3.3.3.2 Public Safety

In 1997, a total of 475 sworn police officers were serving the four-county ROI. In 1997, the average ROI officer-to-population ratio was 2.2 officers per 1,000 persons (Nemeth 1997b). This compares with the 1990 State average of 1.6 officers per 1,000 persons (DOC 1990b). In 1997, 560 paid and volunteer firefighters provided fire protection services in the INEEL ROI. The average firefighter-to-population ratio in the ROI in 1997 was 2.6 firefighters per 1,000 persons (Nemeth 1997b). This compares with the 1990 State average of 1.2 firefighters per 1,000 persons (DOC 1990b). Figure 3–13 displays the ratio of sworn police officers and firefighters to the population for the INEEL ROI.

3.3.3.3.3 Health Care

In 1996, a total of 329 physicians served the ROI. The average ROI physician-to-population ratio was 1.5 physicians per 1,000 persons as compared with a 1996 State average of 1.7 physicians per 1,000 persons (Randolph 1997). In 1997, there were five hospitals serving the four-county ROI. The hospital bed-to-population ratio averaged 4.6 hospital beds per 1,000 persons (Nemeth 1997c). This compares with the 1990 State average of 3.3 beds per 1,000 persons (DOC 1996:128). Figure 3–13 displays the ratio of hospital beds and physicians to the population for all the counties in the INEEL ROI.

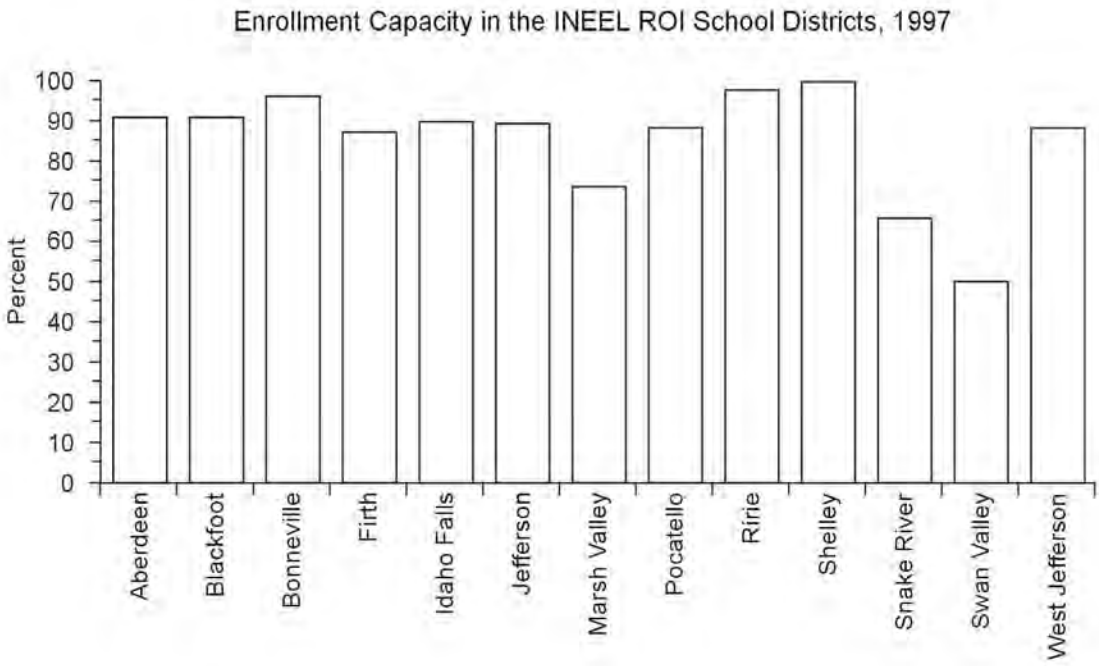
3.3.3.4 Local Transportation

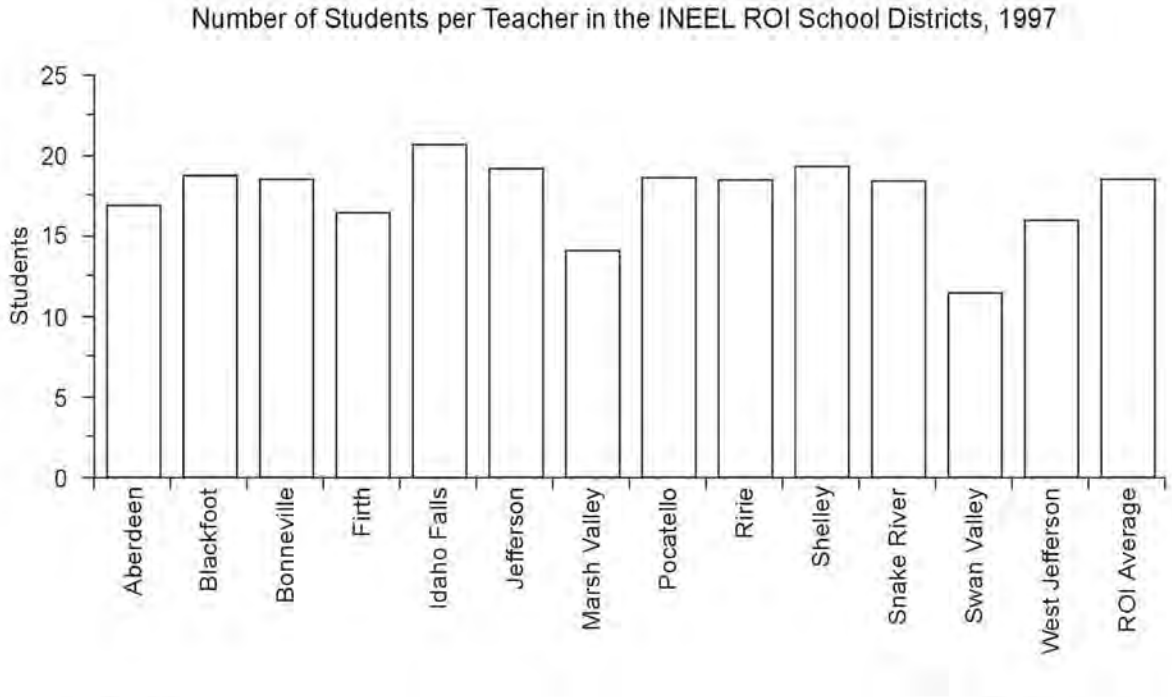
Vehicular access to INEEL is provided by U.S. Routes 20 and 26 to the south and State Routes 22 and 33 to the north. U.S. Routes 20 and 26 and State Routes 22 and 33 all share rights-of-way west of INEEL (see Figure 2–3).

There are two road segments that could be affected by the disposition alternatives: U.S. Route 20 from U.S. Routes 26 and 91 at Idaho Falls to U.S. Route 26 East and U.S. Routes 20 and 26 from U.S. Route 26 East to State Routes 22 and 33.

There are no current road improvement projects affecting access to INEEL; however, there are two planned road improvement projects that could affect future access to INEEL. There are plans to resurface State Route 33 from the intersection of State Routes 28 and 33 to 13 km (8.1 mi) east of this intersection. There are also plans for routine paving of segments along State Route 28 from now until the year 2000 (Bala 1997).

DOE shuttle vans provide transportation between INEEL facilities and Idaho Falls for DOE and contractor personnel. 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 INEEL. A DOE-owned spur connects the Union Pacific Railroad to INEEL by a junction at Scovill Siding. There are no navigable waterways within the ROI capable of accommodating waterborne transportation of material shipments to INEEL. Fanning Field in Idaho Falls





Source: Nemeth 1997a.

ROI Region of influence

Figure 3–12. School District Characteristics for the INEEL Region of Influence

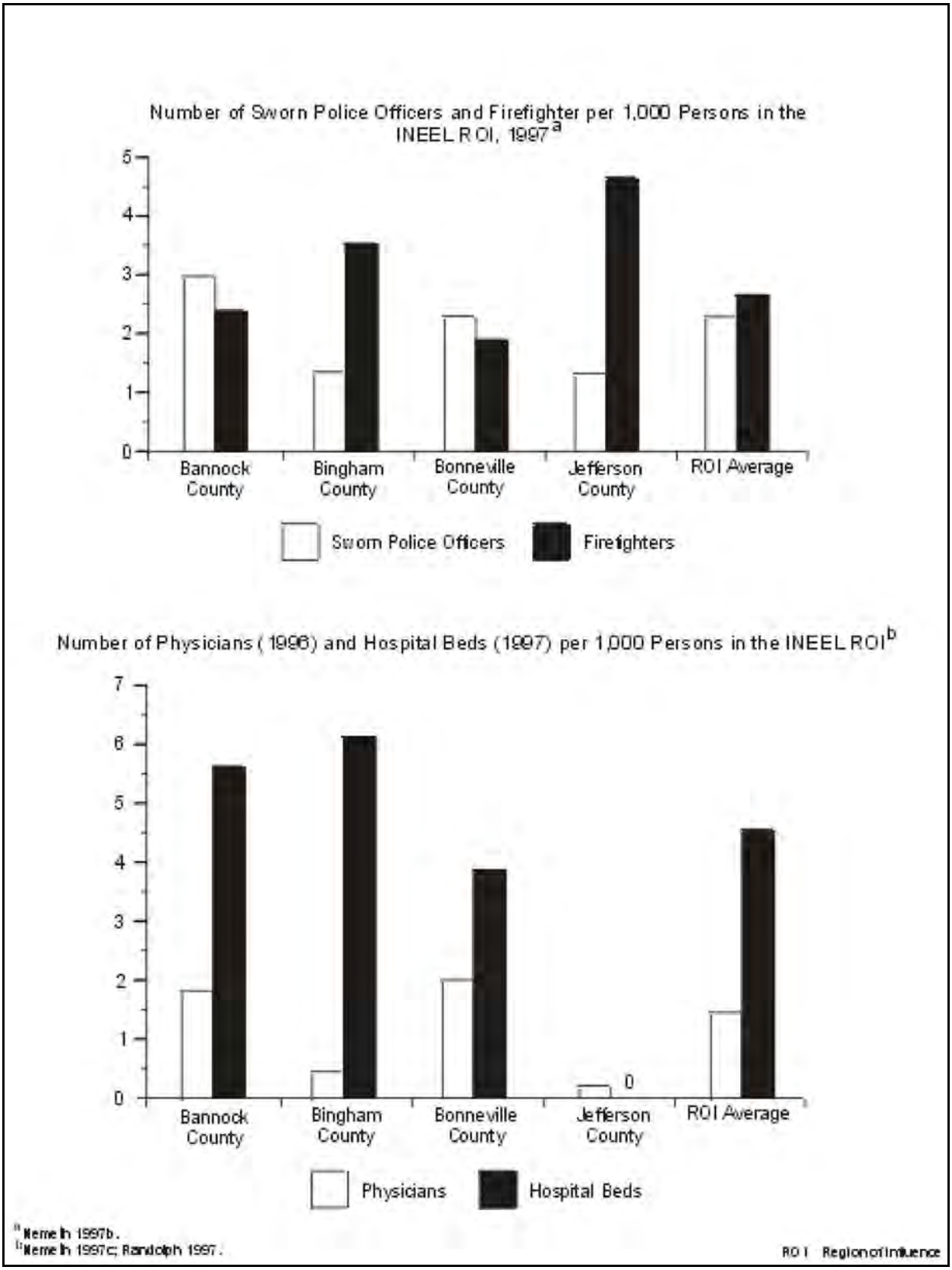


Figure 3–13. Public Safety and Health Care Characteristics for the INEEL Region of Influence

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 (DOE 1996a).

3.3.4 Existing Human Health Risk

Public and occupational health and safety issues include the determination of potentially adverse effects on human health that result from acute and chronic exposures to ionizing radiation and hazardous chemicals.

3.3.4.1 Radiation Exposure and Risk

3.3.4.1.1 General Site Description

Major sources and levels of background radiation exposure to individuals in the vicinity of INEEL are shown in Table 3–20. Annual background radiation doses to individuals are expected to remain constant over time. The total dose to the population, in terms of person-rem, changes as the population size changes. Background radiation doses are unrelated to INEEL operations.

Table 3–20. Sources of Radiation Exposure to Individuals in the INEEL Vicinity Unrelated to INEEL Operations

Source	Effective Dose Equivalent (mrem/yr)
Natural background radiation[a]	
Cosmic radiation	48
External terrestrial radiation	73
Internal terrestrial/cosmogenic radiation	40
Radon in homes (inhaled)	200[b]
Other background radiation[c]	
Diagnostic x rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	426

[a] Mitchell et al. 1997:4-21.
[b] An average for the United States.
[c] NCRP 1987:11, 40, 53.

Releases of radionuclides to the environment from INEEL operations provide another source of radiation exposure to individuals in the vicinity of INEEL. Types and quantities of radionuclides released from INEEL operations in 1996 are listed in *Idaho National Engineering Laboratory Site Environmental Report for Calendar Year 1996* (Mitchell et al. 1997:7-4, 7-5). The doses to the public resulting from these releases are presented in Table 3–21. These doses fall within radiological limits per DOE Order 5400.5 (DOE 1993a:II-1–II-5) and are much lower than those of background radiation.

Using a risk estimator of 500 cancer deaths per 1 million person-rem (5×10^{-4} fatal cancer per person-rem) to the public (see Appendix F.10), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from INEEL operations in 1996 is estimated to be 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 INEEL operations is less than 2 in 100 million. (It takes several to many years from the time of radiation exposure for a cancer to manifest itself.)

Table 3–21. Radiation Doses to the Public From Normal INEEL Operations in 1996 (Total Effective Dose Equivalent)

	Atmospheric Releases		Liquid Releases		Total	
Members of the Public	**Standard[a]**	**Actual**	**Standard[a]**	**Actual**	**Standard[a]**	**Actual**
Maximally exposed individual (mrem)	10	0.031	4	0	100	0.031
Population within 80 km (person-rem)[b]	None	0.24	None	0	100	0.24
Average individual within 80 km (mrem)[c]	None	0.0020	None	0	None	0.0020

[a] The standards for individuals are given in DOE Order 5400.5 (DOE 1993a:II-1–II-5). As discussed in that order, the 10-mrem/yr limit from airborne emissions is required by the Clean Air Act, and the 4-mrem/yr limit is required by the Safe Drinking Water Act; for this SPD EIS, the 4-mrem/yr value is conservatively assumed to be the limit for the sum of doses from all liquid pathways. 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, as published in 58 FR 16268 (DOE 1993b:para. 834.7). If the potential total dose exceeds the 100-person-rem value, it is required that the contractor operating the facility notify DOE.

[b] About 121,500 in 1996.

[c] Obtained by dividing the population dose by the number of people living within 80 km (50 mi) of the site.

Source: Mitchell, Peterson, and Hoff 1996:4-48.

According to the same risk estimator, 1.2×10^{-4} excess fatal cancer is projected in the population living within 80 km (50 mi) of INEEL from normal operations in 1996. To place this number in perspective, it may be compared with the number of fatal cancers expected in the same population from all causes. The 1996 mortality rate associated with cancer for the entire U.S. population was 0.2 percent per year (Famighetti 1998:964). Based on this mortality rate, the number of fatal cancers expected during 1995 from all causes in the population living within 80 km (50 mi) of INEEL was 243. This expected number of fatal cancers is much higher than the 1.2×10^{-4} fatal cancer estimated from INEEL operations in 1996.

INEEL workers receive the same doses as the general public from background radiation, but they also receive an additional dose from working in facilities with nuclear materials. Table 3–22 presents the average dose to the individual worker and the cumulative dose to all workers at INEEL from operations in 1996. These doses fall within the radiological regulatory limits of 10 CFR 835 (DOE 1995a:para. 835.202). According to a risk estimator of 400 fatal cancers per 1 million person-rem among workers[4] (Appendix F.10), the number of projected fatal cancers among INEEL workers from normal operations in 1996 is 0.082.

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 1996* (Mitchell et al. 1997). The concentrations of radioactivity in various environmental media (including air, water, and soil) in the site region (on and off the site) are also presented in that report.

3.3.4.1.2 Proposed Facility Location

External radiation doses and concentrations of gross alpha, plutonium, and americium in air have been measured in the INTEC area. In 1996, the annual average dose along the boundary of INTEC was about 180 mrem. If radiation from the "hot spots" along this boundary (e.g., the tree farm) is not included, the dose is reduced to about 150 mrem. This is about 20 mrem higher than the average dose measured at the offsite control locations. Concentrations in air of gross alpha, plutonium 239/240, and americium 241 in 1995 were 5×10^{-4} pCi/m^3, $2.1\times10^{-}$

[4] The risk estimator for workers is lower than the estimator for the public because of the absence from the workforce of the more radiosensitive infant and child age groups.

^{5} pCi/m^3, and 6×10^{-6} pCi/m^3, respectively. The gross alpha value was about three times lower than that measured at the offsite control locations, and the plutonium 239/240 and americium 241

Table 3–22. Radiation Doses to Workers From Normal INEEL Operations in 1996 (Total Effective Dose Equivalent)

	Onsite Releases and Direct Radiation	
Occupational Personnel	**Standard[a]**	**Actual**
Average radiation worker (mrem)	None[b]	125[c]
Total workers (person-rem)[d]	None	205[c]

[a] The radiological limit for an individual worker is 5,000 mrem/yr (DOE 1995a:para. 835.202). However, DOE's goal is to maintain radiological exposure as low as is reasonably achievable. It has therefore established an administrative control level of 2,000 mrem/yr (DOE 1994a:2-3); the site must make reasonable attempts to maintain individual worker doses below this level.

[b] No standard is specified for an "average radiation worker"; however, the maximum dose that this worker may receive is limited to that given in footnote "a."

[c] Does not include doses received at the Naval Reactors Facility. The impacts associated with this facility fall under the jurisdiction of the Navy as part of the Nuclear Propulsion Program.

[d] About 1,650 (badged) in 1995.

Source: Abbott, Crockett, and Moor 1997.

values were each about 50 percent higher. In 1996, the concentration of gross alpha was about 1×10^{-3} pCi/m^3 in the INTEC area. No measurements of plutonium or americium in air were reported in this area in 1996 (Mitchell, Peterson, and Hoff 1996:4-10, 4-17, 4-18, 4-28, 4-31; Mitchell et al.1997:4-4, 4-19, 4-21, 4-23).

3.3.4.2 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 through which people may come in contact with hazardous chemicals (e.g., surface water during swimming, soil through direct contact, or food). Hazardous chemicals can cause cancer and noncancer health effects. The baseline data for assessing potential health impacts from the chemical environment are addressed in Section 3.3.1.

Effective administrative and design controls that decrease hazardous chemical releases to the environment and help achieve compliance with permit requirements (e.g., air emissions and NPDES permit requirements) contribute to minimizing health impacts on the public. The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts on the public may occur via inhalation of air containing hazardous chemicals released to the atmosphere during normal INEEL operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water or direct exposure, are lower than those via the inhalation pathway. At INEEL, the risk to public health from water ingestion and direct exposure pathways is low because surface water is not used for drinking or as a receptor for wastewater discharges.

Baseline air emission concentrations and applicable standards for hazardous chemicals are addressed in Section 3.3.1. These baseline 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 on estimating the health impacts of hazardous chemicals is presented in Appendix F.10.

Exposure pathways to INEEL workers during normal operation may include the inhalation of contaminants in the workplace atmosphere and direct contact with hazardous materials. The potential for health impacts varies among facilities and workers, and available information is insufficient for a meaningful estimate of impacts. However, workers are protected from workplace hazards through appropriate training, protective equipment, monitoring, substitution, and engineering and management controls. INEEL 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 used in the operational processes ensures that these standards are not exceeded. Additionally, DOE requires that conditions in the workplace be as free as possible from recognized hazards that cause, or are likely to cause, illness or physical harm. Therefore, workplace conditions at INEEL are substantially better than required by standards.

3.3.4.3 Health Effects Studies

Epidemiological studies were conducted on communities surrounding INEEL to determine whether there are excess cancers in the general population. Two of these are described in more detail in Appendix M.4.4 of the *Storage and Disposition PEIS* (DOE 1996a:M-233, M-234). No excess cancer mortality was reported, and although excess cancer incidence was observed, no association thereof with INEEL was established. A study by the State of Idaho completed in June 1996 found excess brain cancer incidence in the six counties surrounding INEEL, but a follow-up survey concluded that "there was nothing that clearly linked all these cases to one another or any one thing."

No occupational epidemiological studies have been completed at INEEL to date, but several worker health studies were initiated recently at INEEL and another is almost complete. Researchers from the Boston University School of Public Health in cooperation with the National Institute of Occupational Safety and Health (NIOSH), are investigating the effects of workforce restructuring (downsizing) in the nuclear weapons industry. The health of displaced workers will be studied. Under a NIOSH cooperative agreement, the epidemiologic evaluation of childhood leukemia and paternal exposure to ionizing radiation now includes INEEL as well as other DOE sites. Another study began in October 1997, *Medical Surveillance for Former Workers at INEEL,* is being carried out by a group of investigators consisting of the Oil, Chemical, and Atomic Workers International Union, Mt. Sinai School of Medicine, the University of Massachusetts at Lowell, and the Alice Hamilton College. A cohort mortality study of the workforce at INEEL being conducted by NIOSH is not expected to be released until December 1998. DOE has implemented an epidemiologic surveillance program to monitor the health of current INEEL workers. A discussion of this program is given in Appendix M.4.4 of the *Storage and Disposition PEIS* (DOE 1996a:M-233, M-234).

3.3.4.4 Accident History

DOE conducted a study, the *Idaho National Engineering Laboratory Historical Dose Evaluation* (DOE/ID-12119), to estimate the potential offsite radiation doses for the entire operating history of INEEL (DOE 1996a:3-139). Releases resulted from a variety of tests and experiments as well as a few accidents at INEEL. 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. There have been no serious unplanned or accidental releases of radioactivity or other hazardous substance at INEEL facilities in the last 10 years of operation.

3.3.4.5 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 to most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program includes emergency planning, preparedness, and response.

Government agencies whose plans are interrelated with the INEEL 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 the Fort Hall Indian Reservation. INEEL contractors are responsible for responding to emergencies at their facilities. Specifically, the emergency action director is responsible for recognition, classification, notifications, and protective action recommendations. At INEEL, 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 INEEL warning communication center, and at the INEEL site emergency operations center. Seven INEEL medical facilities are also available to provide routine and emergency service.

DOE has specified actions to be taken at all DOE sites to implement lessons learned from the emergency response to an accidental explosion at Hanford in May 1997. These actions and the timeframe in which they must be implemented are presented in Section 3.2.4.5.

3.3.5 Environmental Justice

Environmental justice concerns the environmental impacts that proposed actions may have on minority and low-income populations, and whether such impacts are disproportionate to those on the population as a whole in the potentially affected area. In the case of INEEL, the potentially affected area includes only parts of central Idaho.

The potentially affected area surrounding INTEC is defined by a circle with an 80-km (50-mi) radius centered at FPF (lat. 43E34'12.5" N, long. 112E55' 55.4" W). The total population residing within that area in 1990 was 119,138. The proportion of the population there that was considered minority was 9.9 percent. The same census data show that the percentage of minorities for the contiguous United States was 24.1, and for the State of Idaho, 7.8 (DOC 1992).

Figure 3–14 illustrates the racial and ethnic composition of the minority population in the potentially affected area centered at FPF. At the time of the 1990 census, Hispanics and Native Americans were the largest minority groups within that area, constituting 6 percent and 2.6 percent of the total population, respectively, during the 1990 census. Asians constituted about 1 percent, and blacks, about 0.3 percent (DOC 1992).

A breakdown of incomes in the potentially affected area is also available from the 1990 census data (DOC 1992). At that time, the poverty threshold was $9,981 for a family of three with one related child under 18 years of age. A total of 14,386 persons (12.2 percent of the total population) residing within the potentially affected area around INTEC reported incomes below that threshold. Data obtained during the 1990 census also show that of the total population of the contiguous United States, 13.1 percent reported incomes below the poverty threshold, and that Idaho reported 13.3 percent.

3.3.6 Geology and Soils

Geologic resources are consolidated or unconsolidated earth materials, including 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.

3.3.6.1 General Site Description

The upper 1 to 2 km (0.6 to 1.2 mi) of the crust beneath INEEL is composed of interlayered basalt and sediment. The sediments are composed of fine-grained silts that were deposited by wind; silts, sands, and

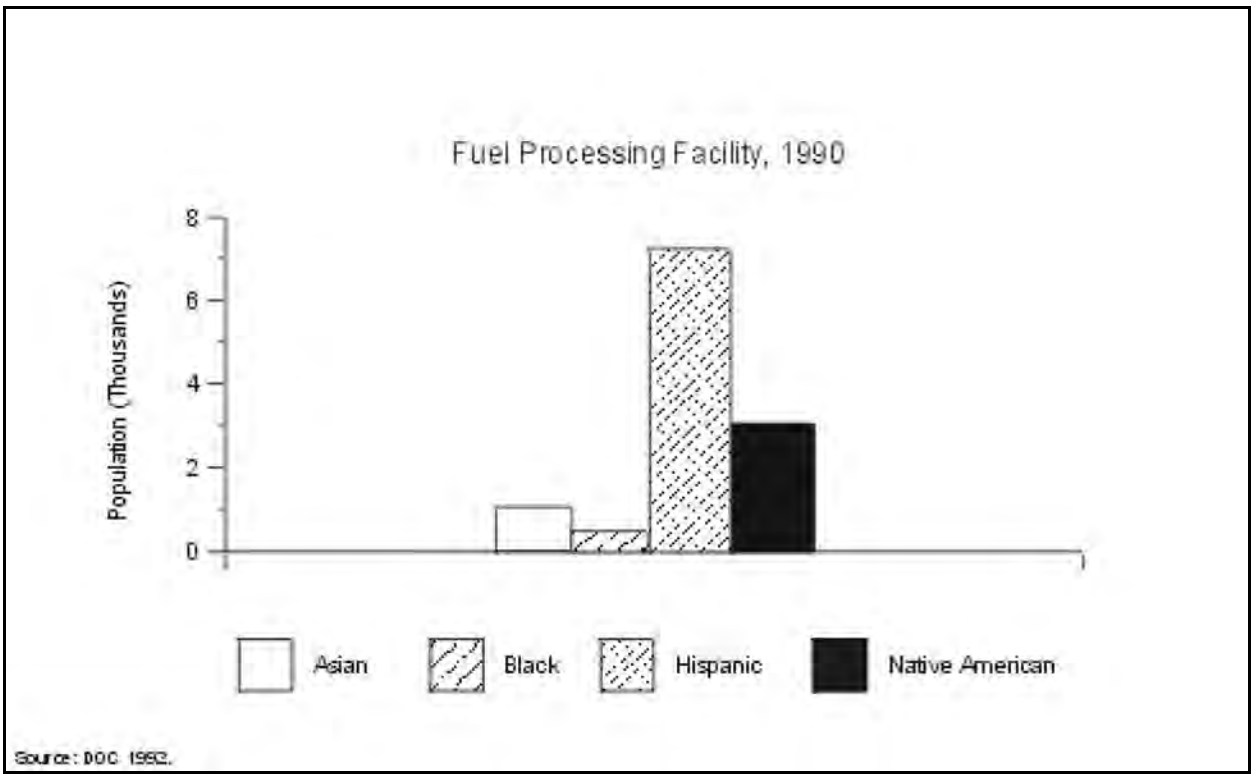


Figure 3–14. Racial and Ethnic Composition of Minorities Around the Fuel Processing Facility at INEEL

gravels deposited by streams; and clays, silts, and sands deposited in lakes. Rhyolitic (granite-like) volcanic rocks of unknown thickness lie beneath the basalt sediment sequence. The rhyolitic volcanic rocks were erupted between 6.5 and 4.3 million years ago (Barghusen and Feit 1995:2.3-17).

Within INEEL, economically viable sand, gravel, and pumice resources have been identified. Several quarries have supplied these materials to various onsite construction projects (DOE 1996a:3-121). Geothermal resources are potentially available in parts of the Eastern Snake River Plain, but neither of two boreholes—INEEL–1 (drilled to a depth of 3,048 m [10,000 ft] to explore for geothermal resources 8 km [5 mi] north of INTEC) and WO–2 (drilled to a depth of 1,524 km [5,000 ft] 4.8 km [3 mi] east of INTEC)—encountered rocks with significant geothermal potential (Abbott, Crockett, and Moor 1997:11).

There is no potential for sinkholes or unstable conditions at INTEC. Lava tubes, which could have adverse effects similar to those of sinkholes, do occur in the INEEL area, but extensive drilling and foundation excavation in the INTEC area over the past few decades has revealed no lava tubes beneath the site. Drilling for foundation engineering investigations at FPF has also revealed no lava tubes (Abbott, Crockett, and Moor 1997:10).

The Arco Segment of the Lost River Fault and the Howe Segment of the Lemhi Fault terminate about 30 km (19 mi) from the INEEL boundary and are considered capable. A capable fault is one that has had movement at or near the ground surface at least once within the past 35,000 years or recurrent movement within the past 500,000 years (DOE 1996a:3-121).

According to the Uniform Building Code, INEEL, located on the Eastern Snake River Plain, is in Seismic Zone 2B, meaning that moderate damage could occur as a result of an earthquake. Historic and recent seismic data cataloged by NOAA, the National Earthquake Information Center, the University of Utah, and the INEEL Seismic Network indicate that earthquakes in the region occur primarily in the Intermountain Seismic Belt and the

Centennial Tectonic Belt. The seismic characteristics of the Eastern Snake River Plain and the adjacent Basin and Range Province are different; the plain has historically experienced few and small earthquakes. No earthquakes have been recorded within about 48 km (30 mi) of the site (DOE 1996a:3-121). An earthquake with a maximum horizontal acceleration of 0.15g is calculated to have an annual probability of occurrence of 1 in 5,000 at a central INEEL location (Barghusen and Feit 1995:2.3-17).

The largest historic earthquake near INEEL took place in 1983 about 107 km (66 mi) to the northwest, near Borah Peak in the Lost River Range. The earthquake had a surface wave magnitude of 7.3 with a resulting peak horizontal ground acceleration of 0.022g to 0.078g at INEEL (Jackson 1985:385). An earthquake of greater than 5.5 magnitude can be expected about every 10 years within a 322-km (200-mi) radius of INEEL (DOE 1996a:3-121).

Volcanic hazards at INEEL can come from sources inside or outside the Snake River Plain. Most of the basaltic volcanic activity occurred at the Craters of the Moon National Monument 20 km (12 mi) southwest of INEEL between 4 million and 2,100 years ago. The probability of volcanic activity affecting facilities at INEEL is very low. In fact, the Volcanism Working Group for the *Storage and Disposition PEIS* (DOE 1996a) estimated that the conditional probability of basaltic volcanism affecting a south-central INEEL location is at most once per 40,000 years. The rhyolite domes along the Axial Volcanic Zone formed between 1.2 million and 300,000 years ago and have a recurrence interval of about 200,000 years. Therefore, the probability of future dome formation affecting INEEL facilities is also very low (DOE 1996a:3-121–3-123).

INEEL soils are derived from volcanic and clastic rocks from nearby highlands. In the southern part of the site, the soils are gravelly to rocky and generally shallow. The northern portion is composed mostly of unconsolidated clay, silt, and sand. No prime farmland lies within the INEEL boundaries. Generally, the soils are acceptable for standard construction techniques (DOE 1996a:3-107, 3-123). More detailed descriptions of the geology and the soil conditions at INEEL are included in the *Storage and Disposition PEIS* (DOE 1996a:3-121–3-123).

3.3.6.2 Proposed Facility Location

The nearest capable fault is in the South Creek Segment of the Lemhi Fault, about 26 km (16 mi) north of INTEC. All soil near INTEC was originally fine loam over a sand or sand-cobble mix deposited in the floodplain of the Big Lost River. However, all soils within the INTEC fences have been disturbed. The soils beneath the INTEC area are not subject to liquefaction because of the high content of gravel mixed with the alluvial sands and silts. In addition, the sediments are not saturated (Abbott, Crockett, and Moor 1997:10).

3.3.7 Water Resources

3.3.7.1 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.

3.3.7.1.1 General Site Description

Three intermittent streams drain the mountains near INEEL: Big Lost River, Little Lost River, and Birch Creek. These intermittent streams carry snowmelt in the spring and are usually dry by midsummer. Several years can pass before any offsite waters enter DOE property. Big Lost River and Birch Creek are the only streams that regularly flow onto INEEL. Little Lost River is usually dry by the time it reaches the site because of upstream use of the flow for irrigation. None of the rivers flow from the site to offsite areas. Big Lost River discharges

into the Big Lost River sinks, and there is no surface discharge from these sinks (Barghusen and Feit 1995:2.3-2, 2.3-21; DOE 1996a:3-115).

Big Lost River has been classified by the State of Idaho for domestic and agricultural use, cold water biota development, salmon spawning, primary and secondary recreation, and other special resource uses. Surface waters, however, are not used for drinking water on the site, nor is any wastewater discharged directly to them. Moreover, there are no surface water rights issues at INEEL, because INEEL facilities currently neither discharge directly to, nor make withdrawals from, these water bodies. None of the rivers have been classified as a Wild and Scenic River. Flood diversion facilities constructed in 1958 secured INEEL from the 300-year flood (DOE 1995b:4.8-1–4.8-5; 1996a:3-115).

3.3.7.1.2 Proposed Facility Location

There are no named streams within INTEC—only unnamed drainage ditches to carry storm flows away from buildings and facilities at the site. Outside INTEC, the only surface water is a stretch of Big Lost River. This is an intermittent stream that flows only after rainfall events or in the spring, when it carries snowmelt from the nearby mountains (Abbott, Crockett, and Moor 1997:5). A summary of water quality data for Big Lost River in the vicinity of INEEL is provided in the *Storage and Disposition PEIS* and shows no unusual concentrations of the parameters analyzed (DOE 1996a:3-115–3-117).

Flooding scenarios that involve the failure of McKay Dam and high flows in the Big Lost River have been evaluated. The results indicate that in the event of a failure of this dam, flooding would occur at INTEC and other facilities at INEEL. The low velocity and shallow depth of the water, however, would not pose a threat of structural damage to the facilities. Localized flooding can occur due to rapid snowmelt and frozen ground conditions, but none has been reported at INTEC (Barghusen and Feit 1995:2.3-21, 2.3-23). A study of the 100-year flood has been completed by the U.S. Geological Survey. The study indicates that the only INEEL facility that would be flooded is the northern part of INTEC and its entrance road. The depth of water over Lincoln Boulevard near its intersection with Monroe Boulevard is estimated at 0.12 to 0.70 m (0.4 to 2.3 ft) (Berenbrock and Kjelstrom 1998:11, 12). The 500-year flood has not been studied (Abbott, Crockett, and Moor 1997:7). However, the probable maximum flood has been calculated, as shown on Figure 3–15 (DOE 1997b).

Purgeable organics such as 1,1-dichloroethylene, toluene, and 1,1,1-trichloroethane have been detected in wells near INTEC. Metals, including arsenic, barium, lead, mercury, selenium, and silver, were also found in samples from wells. Inorganic chemicals such as sodium and chloride have been found in these samples. Maximum values for tritium in samples from three wells averaged 23,700 pCi/l; and maximum strontium 90 values averaged 53 pCi/l (Abbott, Crockett, and Moor 1997:11, 12). These values exceed the drinking water standards for tritium and strontium 90 of 20,000 pCi/l and 8 pCi/l, respectively. The results of groundwater modeling and baseline risk assessment will be used to identify the release sites requiring further evaluation. If necessary, removal actions may be taken to prevent further migration of contaminants to the Snake River Plain Aquifer (Mitchell et al. 1997:3-5). Sanitary waste with no potential for radioactive contamination is treated in the INTEC Sewage Treatment Facility (CPP–615). This facility has a Wastewater Land Application Permit from the State of Idaho and does not discharge to surface waters, but allows land application of treated sanitary sewage. The only effluent criteria associated with flows to the sewage ponds are the amounts of total suspended solids and nitrogen released to the ponds. All compliance points for the ponds are in wells downgradient from the ponds, and the maximum allowable concentrations are similar to those in the National Primary and Secondary Drinking Water Standards (Abbott, Crockett, and Moor 1997:9, 10). Drainage from corridors, roof and floor drains, and condensate from process heating, and heating, ventilation, and air

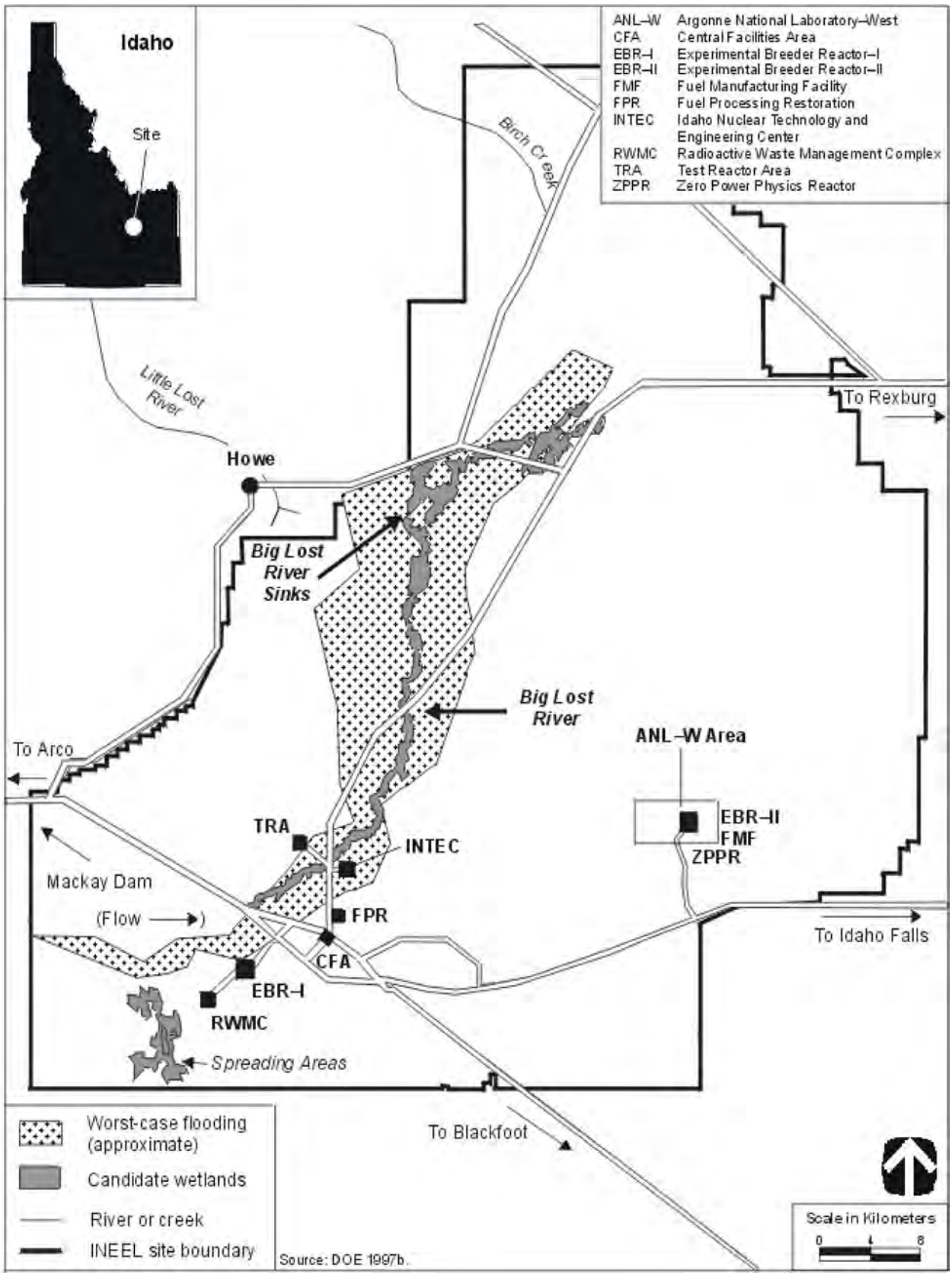


Figure 3–15. Flood Area for the Probable Maximum Flood–Induced Overtopping Failure of the Mackay Dam

conditioning systems with very low potential for radiological contamination are routed to the INTEC service waste system. Service Waste Percolation Pond 1 (SWP–1), southeast of Building CPP–603, has a surface area about of 18,400 m^2 (198,000 ft^2) and is 4.9 m (16 ft) deep. Service Waste Pond 2, immediately west of SWP–1, has a surface area of 46 m^2 (495 ft^2). Both ponds are fenced to keep out wildlife (Abbott, Crockett, and Moor 1997:9).

Consideration is being given to relocating the percolation pond to reduce the potential impacts on a contaminated perched water zone. Consideration is also being given to obtaining an NPDES permit to allow direct discharge into Big Lost River. These actions are independent of the proposed action analyzed in this SPD EIS and would be preceded by appropriate NEPA documentation (Abbott, Crockett, and Moor 1997:10).

3.3.7.2 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.

3.3.7.2.1 General Site Description

The Snake River Plain aquifer is classified by EPA as a Class I sole source aquifer. It lies below the INEEL site and covers about 24,860 km^2 (9,600 mi^2) in southeastern Idaho. This aquifer serves as the primary drinking water source in the Snake River Basin and is believed to contain 1.2 quadrillion to 2.5 quadrillion l (317 trillion to 660 trillion gal) of water. Recharge of the groundwater comes from Henry's Fork of the Snake River, Big Lost River, Little Lost River, and Birch Creek. Rainfall and snowmelt also contribute to the aquifer's recharge (DOE 1996a:3-115–3-117).

Groundwater generally flows laterally at a rate of 1.5 to 6.1 m/day (5 to 20 ft/day). It emerges in springs along the Snake River from Milner to Bliss, Idaho. Depth to the groundwater table ranges from about 60 m (200 ft) below ground in the northeast corner of the site to about 300 m (1,000 ft) in the southeast corner (DOE 1995b:4.8-5; 1996a:3-117).

Perched water tables occur below the site. These perched water tables tend to slow the migration of pollutants that might otherwise reach the Snake River Plain aquifer (DOE 1996a:3-117).

INEEL has a large network of monitoring wells—about 120 in the Snake River Plain aquifer and another 100 drilled in the perched zone. The wells are used for monitoring to determine the compliance of specific actions with requirements of RCRA and CERCLA, as well as routine monitoring to evaluate the quality of the water in the aquifer. The aquifer is known to have been contaminated with tritium; however, the concentration dropped 93 percent between 1961 and 1994, possibly due to the elimination of tritium disposal, radioactive decay, and dispersion throughout the aquifer. Other known contaminants include cesium 137, iodine 129, strontium 90, and nonradioactive compounds such as TCE. Components of nonradioactive waste entered the aquifer as a result of past waste disposal practices. Elimination of groundwater injection exemplifies a change in disposal practices that has reduced the amount of these constituents in the groundwater (DOE 1996a:3-117, 3-119).

From 1982 to 1985, INEEL used about 7.9 billion l/yr (2.1 billion gal/yr) from the Snake River Plain aquifer, the only source of water at INEEL. This represents less than 0.3 percent of the groundwater withdrawn from that aquifer. DOE holds a Federal Reserved Water Right for the INEEL site that permits a pumping capacity of approximately 2.3 m^3/s (80 ft^3/s) with a maximum water consumption of 43 billion l/yr (11 billion gal/yr). INEEL's priority on water rights dates back to its establishment in 1950 (DOE 1996a:3-119).

3.3.7.2.2 Proposed Facility Location

Generally, the groundwater near INEEL, including INTEC, flows from the north and northeast to the south and southwest (Barghusen and Feit 1995:2.3-23).

Water for the INTEC is supplied by two deep wells located in the northwest corner of the INTEC. The wells are about 180 m (590 ft) deep and about 36 cm (14 in) in diameter (Abbott, Crockett, and Moor 1997:9). These wells can each supply up to approximately 11,000 1/min (3,000 gal/min) of water for use in the INTEC fire water, potable water, treated water, and demineralized water systems (Werner 1997). Pumping has little effect on the level of the groundwater, because the withdrawals are so small relative to the volume of water in the aquifer and the amount of recharge available. The production wells at INTEC have historically contained measurable quantities of strontium 90. In 1992, the highest concentration was 1 pCi/l, compared with the EPA maximum Primary Drinking Water Standard of 8 pCi/l. Sampling has yielded similar results over time (Barghusen and Feit 1995:2.3-23–2.3-29).

3.3.8 Ecological Resources

Ecological resources are defined as terrestrial (predominantly land) and aquatic (predominantly water) ecosystems characterized by the presence of native and naturalized plants and animals. For the purposes of this SPD EIS, those ecosystems are differentiated in terms of habitat support of threatened, endangered, and other special-status species—that is, "nonsensitive" versus "sensitive" habitat.

3.3.8.1 Nonsensitive Habitat

Nonsensitive habitat comprises those terrestrial and aquatic areas of the site that typically support the region's major plant and animal species.

3.3.8.1.1 General Site Description

INEEL is dominated by fairly undisturbed shrub-steppe vegetation that provides important habitat for nearly 400 plant species and numerous animal species native to the region's cool desert environment. Facilities and operating areas occupy 2 percent of INEEL, and approximately 60 percent of the surrounding area is used by sheep and cattle for grazing (DOE 1996a:3-125). Six broad vegetative categories representing nearly 20 distinct habitats have been identified on the INEEL site. Approximately 90 percent of INEEL is covered by shrub-steppe vegetation, which is dominated by big sagebrush, saltbrush, rabbitbrush, and native grasses, and contains a diversity of forbs (Figure 3–16) (DOE 1997b:44).

The large, undeveloped tracts of land used by INEEL for safety and security buffers also provide important habitat for plants and animals. Because INEEL is at the mouth of several mountain valleys, large numbers of mammals and migratory birds of prey are funneled onto the site. During some winters, thousands of pronghorn antelope and sage grouse can be found in the low and big sagebrush communities in the northern region. The juniper communities in the northwestern and southwestern regions provide important nesting areas for raptors and songbirds (DOE 1996a:3-125; 1997b:42).

Animal species found at INEEL include 2 species of amphibians, more than 225 species of birds, 6 species of fish, 44 species of mammals, and 11 species of reptiles (Reynolds 1999). Commonly observed animals include the short-horned lizard, gopher snake, sage sparrow, Townsend's ground squirrel, and black-tailed

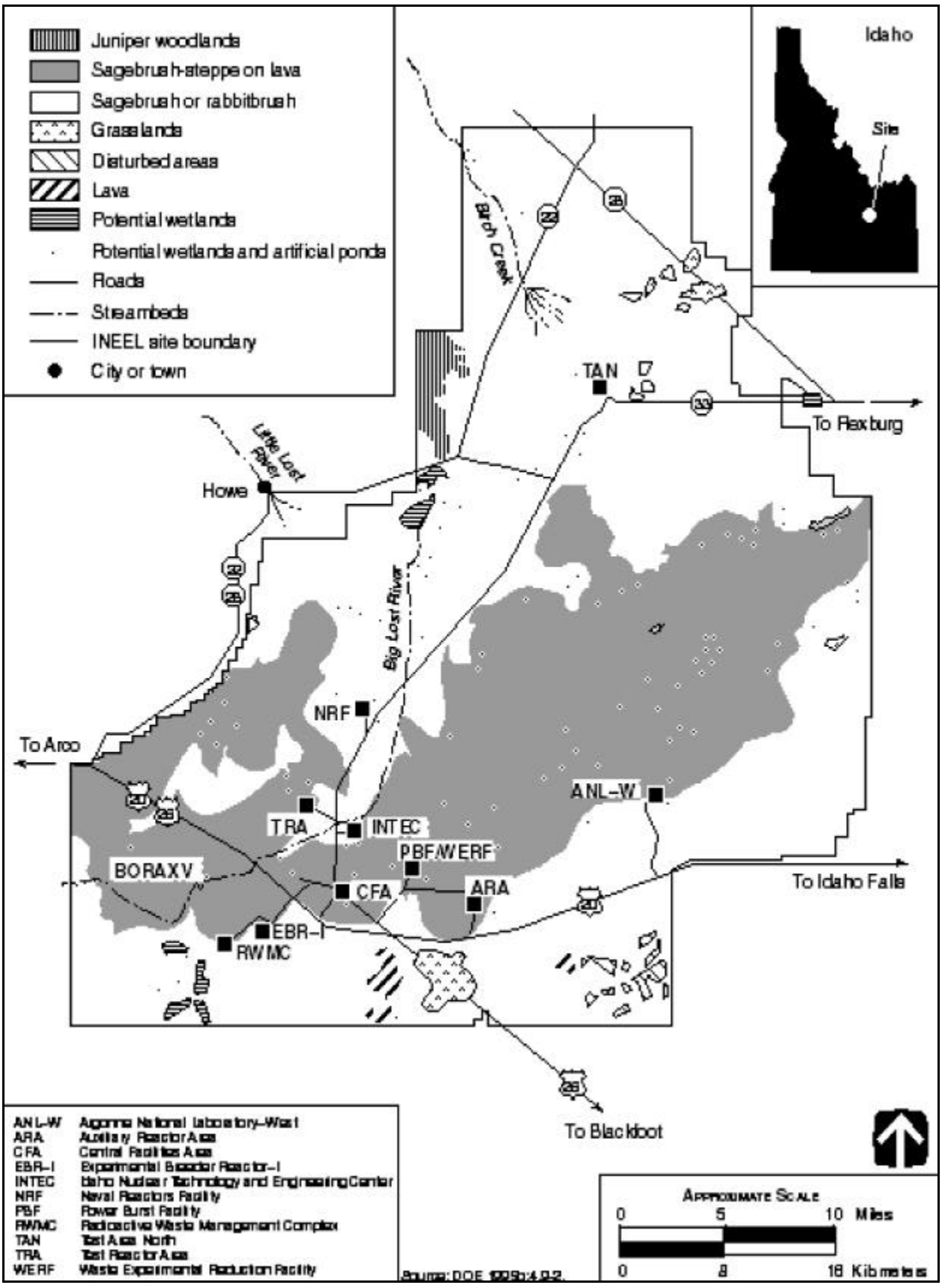


Figure 3–16. Generalized Habitat Types at INEEL

jackrabbit (DOE 1996a:3-125). Important game animals that reside at INEEL include sage grouse, mule deer, and elk. Roughly 30 percent of Idaho's pronghorn antelope population uses INEEL as winter range. Hunting of pronghorn antelope and elk is permitted under controlled conditions to reduce damage to crops on private lands and is restricted to within about 0.8 km (0.5 mi) inside the property boundary of INEEL (DOE 1995b:4.2-1; 1996a:3-125). Predators observed on the INEEL site include bobcats, mountain lions, badgers, and coyotes (DOE 1997b:42).

Aquatic habitat is limited to three intermittent streams (Big Lost River, Little Lost River, and Birch Creek) that drain into four sinks in the north-central portion of INEEL and to a number of liquid-waste disposal ponds. When water from the Big Lost River does flow on the site, several species of fish are observed: brook trout, rainbow trout, mountain whitefish, speckled dace, shorthead sculpin, and kokanee salmon (DOE 1996a:3-125).

3.3.8.1.2 Proposed Facility Location

INTEC is an industrial facility with most land surfaces being disturbed, bare ground (85 percent) or facilities and pavement (13 percent). Natural areas are limited to those areas outside the fenced boundary, mainly sagebrush-steppe on lava, sagebrush, rabbitbrush, and grasslands. The onsite areas are not vegetated except for grasses, shrubs, and trees associated with lawns and landscaping, and weedy annuals and grasses commonly found in disturbed areas. These areas, as well as buildings and wastewater treatment ponds, are used by a number of species. Accordingly, animal species potentially present in the immediate area surrounding FPF are primarily limited to those species adapted to disturbed industrial areas, such as small mammals (e.g., mice, rabbits, and ground squirrels), birds (e.g., sparrows and finches), and reptiles (e.g., lizards). A comprehensive list of species potentially present within INTEC and the surrounding area is presented in the Waste Area Grouping 3 (WAG3) risk assessment work plan developed by Rodriguez et al. (1997) (Werner 1997:WAG3 Report Summary). There are no known aquatic species or habitat within the immediate environs of FPF (Abbott, Crockett, and Moor 1997:15).

3.3.8.2 Sensitive Habitat

Sensitive habitat comprises those terrestrial and aquatic (including designated wetlands) areas of the site that support threatened and endangered, State-protected, and other special-status plant and animal species.[5]

3.3.8.2.1 General Site Description

Nearly all INEEL wetland habitats, with the exception of playa wetlands, are impacted by water management and diversion activities on and off the site. Agricultural demands and flood control diversions, combined with low regional precipitation, prevent permanent water in the Big Lost River and Birch Creek drainages, thus limiting the "classic" wetlands to inordinately wet periods. The Big Lost River and Birch Creek drainages support unique riparian habitats that are important to a diversity of desert animals and breeding birds (DOE 1997b:43, 44). Riparian vegetation, primarily willow and cottonwood, provides nesting habitat for hawks, owls, and songbirds (DOE 1996a:3-125). The only permanent source of surface water on INEEL is manmade ponds where flows are sustained through facility operations. These ponds represent important habitat on INEEL that would not exist otherwise (DOE 1997b:43, 44).

Nineteen threatened, endangered, and other special-status species listed by the Federal Government or the State of Idaho may be found in the vicinity of INEEL, as shown in Table 3.4.6–1 in the *Storage and Disposition PEIS* (DOE 1996a:3-128).

[5] The Federal Government defines threatened and endangered species in the Endangered Species Act, and wetlands in 33 CFR 328.3.

3.3.8.2.2 Proposed Facility Location

There are no known wetlands within the immediate environs of INTEC (Abbott, Crockett, and Moor 1997:15). Manmade percolation ponds that receive permitted facility effluent and hold water intermittently are known to support the boreal chorus frog and aquatic invertebrates when water is present. Several wetland plant species have been identified in percolation ponds south of INTEC (Werner 1997:WAG3 Report Summary). INTEC does not provide critical habitat for any of the 14 threatened, endangered, or other special-status species listed in Table 3–23 that may occur in the area (Werner 1997:WAG3 Report Summary).

Table 3–23. Threatened and Endangered Species, Species of Concern, and Sensitive Species Occurring or Potentially Occurring in Areas Surrounding INTEC

Common Name	Scientific Name	Federal Status	State Status
Birds			
Bald eagle	*Haliaeetus leucocephalus*	Threatened	Endangered
Black tern	*Chlidonias niger*	Species of Concern	Not listed
Burrowing owl	*Athene cunicularia*	Species of Concern	Not listed
Ferruginous hawk	*Buteo regalis*	Species of Concern	Protected
Loggerhead shrike	*Lanius ludovicianus*	Species of Concern	Not listed
Northern goshawk	*Accipiter gentilis*	Species of Concern	Sensitive
Peregrine falcon	*Falco peregrinus*	Endangered	Endangered
Trumpeter swan	*Cygnus buccinator*	Species of Concern	Species of Special Concern
White-faced ibis	*Plegadis chihi*	Species of Concern	Not listed
Mammals			
Long-eared myotis	*Myotis evotis*	Species of Concern	Not listed
Pygmy rabbit	*Brachylagus (Sylvilagus) idahoensis*	Species of Concern	Species of Special Concern
Small-footed myotis	*Myotis subulatus*	Species of Concern	Not listed
Townsend's western big-eared bat	*Plecotus townsendii*	Species of Concern	Species of Special Concern
Plants			
Lemhi milkvetch	*Astragalus aquilonius*	Not listed	Global (Rare) Priority 3
Sepal-tooth dodder	*Cuscuta denticulata*	Not listed	State Priority 1
Spreading gilia	*Ipomopsis polycladon*	Not listed	State Priority 2
Unknown	*Catapyrenium congestum*	Not listed	Sensitive
Winged-seed evening primrose	*Camissonia pterosperma*	Not listed	Sensitive
Reptiles			
Northern sagebrush lizard	*Sceloporus graciosus*	Species of Concern	Not listed

Key: INTEC, Idaho Nuclear Technology and Engineering Center.
Source: Ruesink 1998; Stephens 1998, 1999; Werner 1997:WAG3 Report Summary.

The northern sagebrush lizard and three bat species of special concern are believed to have the greatest potential for occurrence within the environs of INTEC. This is based on a survey conducted in 1996 to evaluate the presence of suitable habitat for threatened and endangered species and species of concern. Bat usage of the area is likely to be limited to aerial hunting activities around the INTEC sewage disposal and percolation ponds. The sewage disposal and percolation ponds are routinely used by wildlife, and these facilities and a portion of the Big

Lost River are within 1 km (0.6 mi) of FPF. The extent of potential usage of facility habitats by the northern sagebrush lizard is unknown (Werner 1997:WAG3 Report Summary).

3.3.9 Cultural and Paleontological Resources

Cultural resources are human imprints on the landscape and are defined and protected by a series of Federal laws, regulations, and guidelines. INEEL has a well-documented record of cultural and paleontological resources. Guidance for the identification, evaluation, recordation, curation, and management of these resources is included in the *Final Draft Idaho National Engineering Laboratory Management Plan for Cultural Resources* (Miller 1995). There have been 1,506 cultural resource sites and isolated finds identified, including 688 prehistoric sites, 38 historic sites, 753 prehistoric isolates, and 27 historic isolates (DOE 1996a:3-129). While many significant cultural resources have been identified, only about 4 percent of the area within the INEEL site has been surveyed (DOE 1996a:3-129). Most surveys have been conducted near major facility areas in conjunction with major modification, demolition, or abandonment of site facilities.

Cultural sites are often occupied continuously or intermittently over substantial time spans. For this reason, a single location (sites) may contain evidence of use during both historic and prehistoric periods. In the discussions that follow, the numbers of prehistoric and historic resources are presented; the sum of these resources may be greater than the total number of sites reported due to this dual-use history at sites. Therefore, where the total number of sites reported is less than the sum of prehistoric and historic sites certain locations were used during both periods.

3.3.9.1 Prehistoric Resources

Prehistoric resources are physical properties that remain from human activities that predate written records.

3.3.9.1.1 General Site Description

Prehistoric resources identified at INEEL are generally reflective of Native American hunting and gathering activities. Resources appear to be concentrated along the Big Lost River and Birch Creek, atop buttes, and within craters or caves. They include residential bases, campsites, caves, hunting blinds, rock alignments, and limited-activity locations such as lithic and ceramic scatters, hearths, and concentrations of fire-affected rock. Most sites have not been formally evaluated for nomination to the National Register, but are considered to be potentially eligible. Given the rather high density of prehistoric sites at INEEL, additional sites are likely to be identified as surveys continue (DOE 1996a:3-129).

3.3.9.1.2 Proposed Facility Location

The INTEC area has been subject to a number of archaeological survey projects over the past two decades. Most of these investigations have been concentrated around the perimeter of the site and along existing roadways or power line corridors. Survey coverage in the area around Building 691 is complete. The inventory of identified resources includes campsites and isolated artifacts reflecting Native American hunting and gathering activities, as well as resources reflective of more recent attempts at homesteading and agriculture (Abbott, Crockett, and Moor 1997:16).

Most of the area near FPF has been surveyed, except for a small area east of the railroad tracks. Six archaeological resources have been identified within the surveyed area. Most of the sites are prehistoric and historic isolates that are not likely to yield additional information and are therefore not likely to be potentially eligible for National Register nomination (Abbott, Crockett, and Moor 1997:16).

3.3.9.2 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.

3.3.9.2.1 General Site Description

Thirty-eight historic sites and 27 historic isolates have been identified at INEEL. These resources are representative of European-American activities, including fur trapping and trading, immigration, transportation, mining, agriculture, and homesteading, as well as more recent military and scientific/engineering R&D activities. Examples of historic resources include Goodale's Cutoff (a spur of the Oregon Trail), remnants of homesteads and ranches, irrigation canals, and a variety of structures from the World War II era. Experimental Breeder Reactor I, the first reactor to achieve a self-sustaining chain reaction using plutonium instead of uranium as the principal fuel component, is listed on the National Register and is designated a National Historic Landmark. Many other INEEL structures built between 1949 and 1974 are considered eligible for the National Register because of their exceptional scientific and engineering significance and their major role in the development of nuclear science and engineering since World War II. According to current studies, additional historic sites are likely to exist in unsurveyed portions of INEEL (DOE 1996a:3-129).

3.3.9.2.2 Proposed Facility Location

In the study area near INTEC are two historic sites, a homestead and nearby trash dump, that may be eligible for nomination to the National Register. These sites are potential sources of information on Carey Land Act–sponsored agricultural activities in the region (Abbott, Crockett, and Moor 1997:16).

A historic resource inventory of all buildings within INTEC is being conducted and will likely identify additional historic structures built between 1949 and 1974. Because it was constructed after 1974, FPF is not considered to be historic (Abbott, Crockett, and Moor 1997:16).

3.3.9.3 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.

3.3.9.3.1 General Site Description

Native American resources at INEEL are associated with the two groups of nomadic hunters and gatherers that used the region at the time of European-American contact: the Shoshone and Bannock. Both of these groups used the area that now encompasses INEEL as they harvested floral and faunal resources and obsidian from Big Southern Butte or Howe Point. Because INEEL is considered part of the Shoshone-Bannock Tribes' ancestral homeland, it contains many localities that are important for traditional, cultural, educational, and religious reasons. This includes not only prehistoric archaeological sites, which are important in a religious or cultural heritage context, but also features of the natural landscape and air, plant, water, or animal resources that have special significance (DOE 1996a:3-129).

3.3.9.3.2 Proposed Facility Location

INTEC and the surrounding area may contain Native American resources. The existence and significance of any resources near INTEC would be established in direct consultation with the Shoshone and Bannock Tribes. INEEL recently initiated general consultation with the Shoshone and Bannock Tribes, and a working agreement was established (Abbott, Crockett, and Moor 1997:16, B-1, B-2). Consultations (see Chapter 5 and Appendix O) were initiated with appropriate Native American groups to determine any concerns associated with the actions evaluated in this SPD EIS.

3.3.9.4 Paleontological Resources

Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geological age.

3.3.9.4.1 General Site Description

Paleontological remains consist of fossils and their associated geologic information. The region encompassing INEEL has abundant and varied paleontological resources, including plant, vertebrate, and invertebrate remains from soils and lake and river sediments, and organic materials found in caves and archaeological sites (DOE 1995b:4.4-5).

3.3.9.4.2 Proposed Facility Location

Vertebrate fossils recovered from the Big Lost River floodplain consist of isolated bones or teeth from large mammals of the Pleistocene or Ice Age. These fossils were discovered during excavations and well-drilling operations. A single mammoth tooth was salvaged during the excavation of a percolation pond immediately south of INTEC. Other fossils have been recorded in the vicinities of the Test Reactor Area and Naval Reactors Facility. Occasional skeletal elements of fossil mammoth, horse, and camel have been retrieved from the Big Lost River diversion dam and Radioactive Waste Management Complex on the southwestern side of INEEL, and from river and alluvial fan gravels and Lake Terreton sediments near Test Area North (Abbott, Crockett, and Moor 1997:16).

3.3.10 Land Use and Visual Resources

3.3.10.1 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, cultural, geological, aquatic, and atmospheric).

INEEL is situated on approximately 2,300 km^2 (890 mi^2) of land in southeastern Idaho (DOE 1997b). INEEL is owned by the Federal Government and administered, managed, and controlled by DOE (DOE 1996a:3-107). It is primarily within Butte County, but portions of the site are also in Bingham, Jefferson, Bonneville, and Clark Counties. The site is roughly equidistant from Salt Lake City, Utah, and Boise, Idaho.

3.3.10.1.1 General Site Description

Lands surrounding INEEL are owned by the Federal Government, the State of Idaho, and private parties. Regional land uses include grazing, wildlife management, rangeland, mineral and energy production, recreation, and crop

production. Approximately 60 percent of the surrounding area is used by sheep and cattle for grazing. Small communities and towns near the INEEL boundaries include Mud Lake to the east; Arco, Butte City, and Howe to the west; and Atomic City to the south (DOE 1995b:4.2-5). Two National Natural Landmarks border INEEL: Big Southern Butte (2.4 km [1.5 mi] south) and Hell's Half Acre (2.6 km [1.6 mi] southeast) (DOE 1996a:3-107). A portion of Hell's Half Acre National Natural Landmark is designated as a Wilderness Study Area. The Black Canyon Wilderness Study Area is also adjacent to INEEL (DOE 1996a:3-107).

Land-use categories at INEEL include facility operations, grazing, general open space, and infrastructure such as roads. Generalized land uses at INEEL and vicinity are shown in Figure 3–17. Facility operations include industrial and support operations associated with energy research and waste management activities. Land is also used for recreation and environmental research associated with the designation of INEEL as a National Environmental Research Park. Much of INEEL is open space that has not been designated for specific use. Some of this space serves as a buffer zone between INEEL facilities and other land uses. About 2 percent of the total INEEL site area (46 km^2 [18 mi^2]) is used for facilities and operation (DOE 1995b:4.2-1). Approximately 9,000 ha (22,240 acres) or 4 percent of the total acreage at INEEL is available for radioactive waste management facilities (DOE 1997a:vol. I, 4-20). Public access to most facilities is restricted. Approximately 6 percent of the INEEL site, or 140 km^2 (54 mi^2), is public roads and utilities that cross the site. Recreational uses include public tours of general facility areas and Experimental Breeder Reactor I (a National Historic Landmark), and controlled hunting, which is generally restricted to 0.8 km (0.5 mi) within the INEEL boundary. Between 1,210 km^2 (467 mi^2) and 1,420 km^2 (548 mi^2) are used for cattle and sheep grazing. A 3.6-km^2 (1.4-mi^2) portion of this land, at the junction of Idaho State Highways 28 and 33, is used by the U.S. Sheep Experiment Station as a winter feedlot for about 6,500 sheep (DOE 1995b:4.2-1).

INTEC is about 4.8 km (3 mi) north of the Central Facilities Area. The plant is situated on approximately 85 ha (210 acres) within the perimeter fence. An additional 22 ha (54 acres) of the plant area lie outside the fence (DOE 1997b). The INTEC complex houses reprocessing facilities for Government-owned defense and research spent fuels. Facilities at INTEC include spent fuel storage and reprocessing areas, a waste solidification facility and related waste storage bins, remote analytical laboratories, and a coal-fired steam-generating plant.

DOE land-use plans and policies applicable to INEEL include the *INEL Institutional Plan for FY 1994–1999* and the *INEL Technical Site Information Report* (DOE 1995b:vol. 2, part A, 4.2-1). The *Institutional Plan* provides a general overview of INEEL facilities, strategic program descriptions, and major construction projects, and identifies specific technical programs and capital equipment needs. The *Information Report* (DOE 1995b:vol. 2, part A) presents a 20-year master plan for development activities at the site. Land-use planning for INEEL administrative and laboratory facilities located in the city of Idaho Falls is subject to Idaho Falls planning and zoning restrictions (DOE 1996a:3-107).

All county plans and policies encourage development adjacent to previously developed areas to minimize the need for infrastructure improvements and to avoid urban sprawl. Because INEEL is remote from most developed areas, INEEL lands and adjacent areas are not likely to experience residential and commercial development, and no new development is planned near the site. Recreational and agricultural uses, however, are expected to increase in the surrounding area in response to greater demand for recreational areas and the conversion of rangeland to cropland (DOE 1995b:4.2-5).

The Fort Bridger Treaty of July 3, 1868, secured the Fort Hall Reservation as the permanent homeland of the Shoshone-Bannock Peoples. According to the treaty, tribal members reserved rights to hunting, fishing, and gathering on surrounding unoccupied lands of the United States. While INEEL is considered occupied land, it was recognized that certain areas on the INEEL site have significant cultural and religious significance to

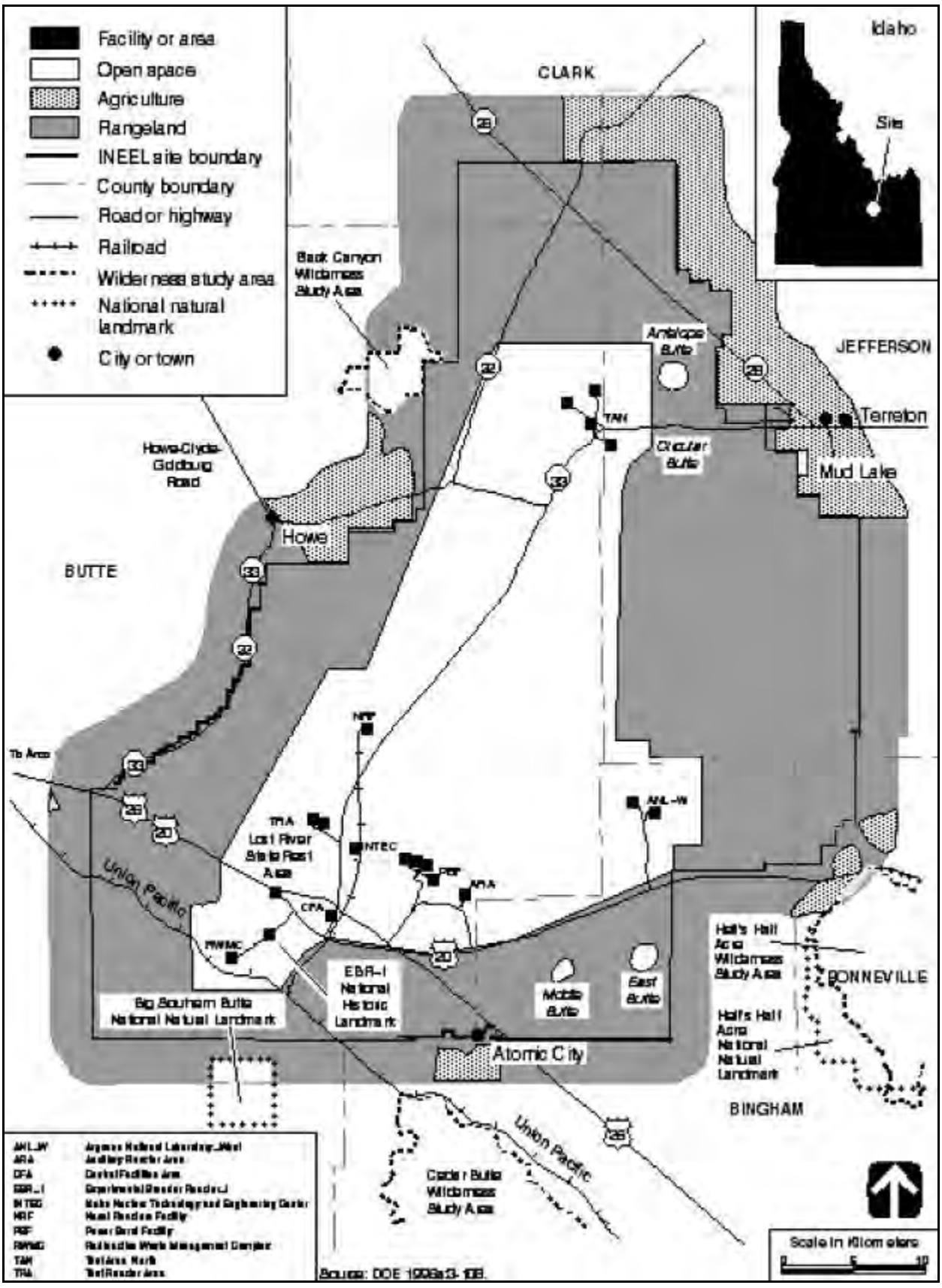


Figure 3–17. Generalized Land Use at INEEL and Vicinity

the tribes. A *1994 Memorandum of Agreement with the Shoshone-Bannock Tribes* (DOE 1994b:1) provides tribal members access to the Middle Butte to perform sacred or religious ceremonies or other educational or cultural activities.

3.3.10.1.2 Proposed Facility Location

FPF is not currently being used and is being maintained on standby. This building, the largest at INTEC, is in the middle of an area of several warehouse and administrative facilities. The land, currently disturbed, is designated for waste-processing operations. FPF is 12 km (7.5 mi) from the nearest site boundary.

3.3.10.2 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.

3.3.10.2.1 General Site Description

The INEEL site is bordered on the north and west by the Bitterroot, Lemhi, and Lost River mountain ranges. Volcanic buttes near the southern boundary of INEEL can be seen from most locations on the site. INEEL generally consists of open desert land predominantly covered by large sagebrush and grasslands. Pasture and farmland border much of the site.

Ten facility areas are on the INEEL site. Although INEEL has a master plan, no specific visual resource standards have been established. INEEL facilities have the appearance of low-density commercial/industrial complexes widely dispersed throughout the site. Structure heights range from about 3 to 30 m (10 to 100 ft); a few stacks and towers reach 76 m (250 ft). Although many INEEL facilities are visible from highways, most facilities are more than 0.8 km (0.5 mi) from public roads (DOE 1995b:4.5-1). The operational areas are well defined at night by the security lights.

The Craters of the Moon National Monument is about 20 km (12 mi) southwest of INEEL's western boundary. It includes a designated Wilderness Area, which must maintain Class I air quality standards. Lands adjacent to the site, under BLM jurisdiction, are designated as VRM Class II areas (DOE 1995b:4.5-2). This designation obliges preservation and retention of the existing character of the landscape. Lands within the INEEL site are designated as VRM Classes III and IV, the most lenient classes in terms of modification (DOE 1995b:4.5-2). The Black Canyon Wilderness Study Area, adjacent to INEEL, is under consideration by BLM for Wilderness Area designation, approval of which would result in an upgrade of its VRM class from Class II to Class I (DOE 1995b:4.5-2; DOI 1986a, 1986b). The Hell's Half Acre Wilderness Study Area is about 2.6 km (1.6 mi) southeast of INEEL's eastern boundary. This area, famous for its lava flows and hiking trails, is managed by BLM.

3.3.10.2.2 Proposed Facility Location

While FPF is the largest building on the site, the tallest structure is the stack connected to INTEC; it is 76 m (250 ft) tall. INTEC is visible in the middle ground from State Highways 20 and 26, with Saddle Mountain in the background. The character of INTEC is consistent with a VRM Class IV designation (DOI 1986a, 1986b). Natural features of visual interest within a 40-km (25-mi) radius include Big Lost River at 0.8 km (0.5 mi), Big Southern Butte National Natural Landmark at 20 km (12 mi), Saddle Mountain at 40 km (25 mi), Middle Butte

at 18 km (11 mi), Hell's Half Acre Wilderness Study area at 35 km (22 mi) and East Butte at 23 km (14 mi) (Abbott, Crockett, and Moor 1997:4).

3.3.11 Infrastructure

Site infrastructure includes those utilities and other resources required to support construction and continued operation of mission-related facilities identified under the various proposed alternatives.

3.3.11.1 General Site Description

INEEL has extensive production, service, and research facilities. An extensive infrastructure supports these facilities, as shown in Table 3–24.

Table 3–24. INEEL Sitewide Infrastructure Characteristics

Resource	Current Usage	Site Capacity
Transportation		
Roads (km)	445[a]	445[a]
Railroads (km)	48	48
Electricity		
Energy consumption (MWh/yr)	232,500	394,200
Peak load (MW)	42	124
Fuel		
Natural gas (m^3/yr)	NA	NA
Oil (l/yr)[b]	5,820,000	16,000,000[c]
Coal (t/yr)	11,340	11,340[c]
Water (l/yr)	6,000,000,000[d]	43,000,000,000[e]

[a] Includes paved and unpaved roads.
[b] Includes fuel oil and propane.
[c] As supplies get low, more can be supplied by truck or rail.
[d] See Werner 1997:2.
[e] See DOE 1995b:vol. II, part A, 4.13-1.
Key: NA, not applicable.
Source: DOE 1996a:3-110.

3.3.11.1.1 Transportation

The road network at INEEL provides for onsite transportation; the railroads for deliveries of large volumes of coal and oversized structural components. Commercial shipments are by truck and plane, but some bulk materials are transported by train, and waste by truck and train (DOE 1995b:vol. I, 4.11-1).

About 140 km (87 mi) of paved surface has been developed out of the 445 km (277 mi) of roads on the site, including about 29 km (18 mi) of service roads that are closed to the public. Most of the roads are adequate for the current level of normal transportation activity and could handle increased traffic volume (DOE 1995b:vol. I, 4.11-1).

Idaho Falls receives railroad freight service from Butte, Montana, to the north, and from Pocatello, Idaho, and Salt Lake City, Utah, to the south. The Union Pacific Railroad's Blackfoot-to-Arco Branch crosses the southern portion of INEEL and provides rail service to the site. This branch connects with a DOE spur line at the Scoville

Siding, then links with developed areas within INEEL. Rail shipments to and from INEEL usually are limited to bulk commodities, spent nuclear fuel, and radioactive waste (DOE 1995b:vol. I, 4.11-3).

3.3.11.1.2 Electricity

Commercial electric power is supplied to INEEL from the Antelope substation through two feeders to the federally owned Scoville substation, which supplies electric power directly to the site electric power distribution system. Electric power supplied by Idaho Power Company is generated by hydroelectric generators along the Snake River in southern Idaho and by the Bridger and Valmy coal-fired thermal electric generation plants in southwestern Wyoming and northern Nevada (DOE 1995b:vol. II, part A, 4.13-2). Characteristics of this power pool are summarized in Table 3.4.2–2 of the *Storage and Disposition PEIS* (DOE 1996a:3-111).

The average electrical availability at INEEL is about 394,200 MWh/yr; the average usage, about 232,500 MWh/yr. The peak load capacity for INEEL is 124 MW; the current peak load usage, about 42 MW (DOE 1996a:3-110).

3.3.11.1.3 Fuel

Fuels consumed at INEEL include several liquid petroleum fuels, coal, and propane gas. All fuels are transported to the site for storage and use. Fuel storage is provided for each facility, and the inventories are restocked as necessary (DOE 1995b:vol. II, part A, 4.13-2). The current site usage is about 5.8 million l/yr (1.5 million gal/yr). The current site usage of coal is about 11,340 t/yr (12,500 tons/yr) (DOE 1996a:3-110). If additional coal or fuel oil were needed during the year, it could be shipped onto the site.

3.3.11.1.4 Water

The Snake River Plain Aquifer is the source of all water at INEEL (DOE 1996a:3-119). The water is provided by a system of about 30 wells, together with pumps and storage tanks. That system is administered by DOE, which holds the Federal Reserved Water Right for the site of 43 billion 1/yr (11 billion gal/yr) (DOE 1995b:vol. II, part A, 4.13-1). The current site usage is 6 billion 1/yr (1.6 billion gal/yr) (Werner 1997:2).

3.3.11.1.5 Site Safety Services

DOE operates three fire stations at INEEL. These stations are at the north end of Test Area North, at ANL–W, and in the Central Facilities Area. Each station has a minimum of one engine company capable of supporting any fire emergency in its assigned area. The fire department also provides the site with ambulance, emergency medical technician, and hazardous material response services (DOE 1995b:vol. II, part A, 4.13-3).

3.3.11.2 Proposed Facility Location

A separate utility tunnel running off the main INTEC utility tunnel was completed and water, steam condensate, air, and other lines have been completed up to, and in some cases into, FPF when this facility was built. A summary of the infrastructure characteristics of INTEC is presented as Table 3–25.

3.3.11.2.1 Electricity

Electric power for INTEC is routed into the main electrical room from a 14-kV feeder in Unit Substation 2, north of the building. The current capacity available for INTEC is 262,800 MWh/yr (Abbott, Crockett, and Moor 1997:20).

Table 3–25. INEEL Infrastructure Characteristics for INTEC

Resource	Current Usage	Capacity
Electricity		
Energy consumption (MWh/yr)	60,000	262,800
Peak load (MW)	9.2[a]	31.4[b,c]
Fuel		
Natural gas (m^3/yr)	NA	NA
Oil (l/yr)	757,000	1,112,720[d,e]
Coal (t/yr)	13,000	NA[e]
Water (l/yr)	45,420,000	227,100,000

[a] Demand.
[b] Equivalent to 30 MW continuous use per year.
[c] Based on a 95 percent power factor.
[d] Available capacity is INTEC tank storage capacity in liters.
[e] As supplies get low, more can be supplied by truck or rail.

Key: INTEC, Idaho Nuclear Technology and Engineering Center; NA, not applicable.

Source: Abbott, Crockett, and Moor 1997:20; Werner 1997:1.

3.3.11.2.2 Fuel

Fuel oil and propane are supplied from INTEC. The current capacity of fuel oil and propane is approximately 1.1 million l/yr (291,000 gal/yr); the usage, approximately 757,000 l/yr (200,000 gal/yr) (Abbott, Crockett, and Moor 1997:20).

3.3.11.2.3 Water

Water service is available through connection to the INTEC water supply system, which obtains its water from two deep wells located north of the INTEC main process area. The water withdrawn from the Snake River Plain Aquifer is a small fraction of the available supply (Abbott, Crockett, and Moor 1997:9). The current annual capacity of water available for FPF is about 230 million l/yr (61 million gal/yr); and the current usage for the facility is about 45 million l/yr (12 million gal/yr) (Werner 1997:1).

3.4 PANTEX PLANT

Pantex is in Carson County along U.S. Highway 60 and lies about 27 km (17 mi) northeast of downtown Amarillo, Texas (Figure 2–4). Pantex lies in the Texas Panhandle on the Llano Estacado (staked plains) portion of the Great Plains. The topography at Pantex is relatively flat, characterized by rolling grassy plains and 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 nearby (DOE 1996a:3-146).

Pantex was first used by the U.S. Army for loading conventional ammunition shells and bombs from 1942 to 1945. In 1951, the Atomic Energy Commission arranged to begin rehabilitating portions of the original plant and constructing new facilities for nuclear weapons operations. The current missions are shown in Table 3–26. Weapons assembly, disassembly, and stockpile surveillance activities involve handling (but not processing) of encapsulated uranium, plutonium, and tritium, as well as a variety of nonradioactive hazardous or toxic chemicals (DOE 1996a:3-146).

Table 3–26. Current Missions at Pantex

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
Weapons assembly	Assemble new nuclear weapons for the stockpile	Assistant Secretary for Defense Programs
Weapons 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
Weapons disassembly	Disassemble stockpile weapons as required	Assistant Secretary for Defense Programs
Test and 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
Waste management	Waste treatment, storage, and disposal	Assistant Secretary for Defense Programs
Environmental management	Environmental restoration activities	Assistant Secretary for Environmental Management

Source: DOE 1996a:3-146.

DOE Activities. All DOE activities at Pantex, except for environmental restoration programs, fall under the DOE Office of the Assistant Secretary for Defense Programs. Historically, DOE's mission for Pantex primarily included assembly and delivery to the U.S. Department of Defense (DoD) of a variety of nuclear weapons. Today, the primary roles of Pantex are the disassembly of U.S. nuclear weapons being returned to DOE by DoD, maintenance and repair of nuclear weapons, and storage of plutonium pits. These operations are in compliance with the negotiated downsizing of the U.S. and the former Soviet nuclear forces (DOE 1996a:3-147).

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 high-explosive components for nuclear weapons. DOE also conducts quality evaluation of weapons, quality assurance testing of weapons components, and R&D supporting nuclear weapons activities at the plant. DOE's national security responsibilities are mandated by statutes, Presidential directives, and congressional authorization and appropriations (DOE 1996a:3-147).

The change in mission emphasis from assembly to disassembly of nuclear weapons has caused an increase in some waste streams. Waste management operations at Pantex in the near term 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. Upon completion of the current backlog of dismantlements due to stockpile reduction, waste generation is likely to decrease (DOE 1996a:3-147).

Non-DOE Activities. Texas Tech University pursues agricultural activities on both DOE-owned and DOE-leased property (DOE 1996a:3-147).

3.4.1 Air Quality and Noise

3.4.1.1 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. Air pollutants are transported, dispersed, or concentrated by meteorological and topographical conditions. Air quality is affected by air pollutant emission characteristics, meteorology, and topography.

3.4.1.1.1 General Site Description

The climate at Pantex and the surrounding region is characterized as semiarid with hot summers and rather cold winters. The average annual temperature in the Amarillo region is 13.8 EC (56.9 EF); temperatures range from an average daily minimum of -5.7 EC (21.8 EF) in January to an average daily maximum of 32.8 EC (91.1 EF) in July. The average annual precipitation is 49.8 cm (19.6 in). Prevailing winds at Pantex are from the south. The average annual windspeed is 6 m/s (13.5 mph) (NOAA 1994a). Additional information related to meteorology and climatology at Pantex is presented in Appendix F of the *Storage and Disposition PEIS* (DOE 1996a:F-11, F-12) and in the site environmental information document (M&H 1996a:6-1–6-19).

Pantex is within the Amarillo-Lubbock Intrastate AQCR #211. None of the areas within Pantex and this AQCR are designated as nonattainment areas with respect to the NAAQS for criteria air pollutants (EPA 1997e). Applicable NAAQS and Texas State ambient air quality standards are presented in Table 3–27.

There are no PSD Class I areas within 100 km (62 mi) of Pantex. None of the facilities at Pantex have been required to obtain a PSD permit (DOE 1996f:4-118–4-120).

The primary emission sources of criteria pollutants at Pantex are the steam plant boilers, the explosives-burning operation, and emissions from onsite vehicles. Emission sources of hazardous or toxic air pollutants include the high-explosives synthesis facility, the explosives-burning operation, paint spray booths, miscellaneous laboratories, and other small operations (DOE 1996f:4-134). The boilers and high-explosives synthesis facility operate under air permits from the Texas Natural Resource Conservation Commission (TNRCC). The paint

Table 3–27. Comparison of Ambient Air Concentrations From Pantex Sources With Most Stringent Applicable Standards or Guidelines, 1993

Pollutant	Averaging Period	Most Stringent Standard or Guideline (Fg/m^3)[a]	Concentration (Fg/m^3)
Criteria pollutants			
Carbon monoxide	8 hours	10,000[b]	161
	1 hour	40,000[b]	924
Nitrogen dioxide	Annual	100[b]	0.90
Ozone	8 hours	157[c]	(d)
PM_{10}	Annual	50[b]	8.73
	24 hours	150[b]	88.5
$PM_{2.5}$	3-year annual	15[c]	(e)
	24 hours (98th percentile over 3 years)	65[c]	(e)
Sulfur dioxide	Annual	80[b]	<0.01
	24 hours	365[b]	<0.01
	3 hours	1,300[b]	<0.01
	30 minutes	1,048[f]	<0.01
Other regulated pollutants			
Hydrogen sulfide	30 minutes	112[f]	(g)
Total suspended particulates	3 hours	200[f]	(h)
	1 hour	400[f]	(h)
Hazardous and other toxic compounds			
Benzene	1 hour	75[i]	19.4[j]
	Annual	3[i]	0.0547
[Text deleted.]			

[a] The more stringent of the Federal and State standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (NAAQS) (EPA 1997a), other than those for ozone, particulate matter, lead, and those based on annual averages, are not to be exceeded more than once per year. The 1-hr ozone standard is attained when the expected number of days per year with maximum hourly average concentrations above the standard is #1. The 1-hr ozone standard applies only to nonattainment areas. The 8-hr ozone standard is attained when the 3-year average of the annual fourth-highest daily maximum 8-hr average concentration is less than or equal to 157 Fg/m^3. The 24-hr particulate matter standard is attained when the expected number of days with a 24-hr average concentration above the standard is #1. The annual arithmetic mean particulate matter standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard.

[b] Federal and State standard.

[c] Federal standard.

[d] Not directly emitted or monitored by the site.

[e] No data is available with which to assess $PM_{2.5}$ concentrations.

[f] State standard.

[g] No sources identified at the site.

[h] No site boundary concentrations from Pantex facilities presented in the *Final EIS for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components*.

[i] TNRCC effects-screening levels are "tools" used by the Toxicology and Risk Assessment Staff to evaluate impacts of air pollutant emissions. They are not ambient air standards. If ambient levels of air contaminants exceed the screening levels, it does not necessarily indicate a problem, but would trigger a more indepth review. The levels are set where no adverse effect is expected.

[j] Concentration reported as a 30-min average.

Note: The NAAQS also includes standards for lead. No sources of lead emissions have been identified for any of the alternatives presented in Chapter 4. Emissions of other air pollutants not listed here have been identified at Pantex, but are not associated with any of the alternatives evaluated. These other air pollutants are quantified in the *Final EIS for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components* (DOE 1996f). EPA recently revised the ambient air

quality standards for particulate matter and ozone. The new standards, finalized on July 18, 1997, changed the ozone primary and secondary standards from a 1-hr concentration of 235 Fg/m^3 (0.12 ppm) to an 8-hr concentration of 157 Fg/m^3 (0.08 ppm). During a transition period while States are developing State implementation plan revisions for attaining and maintaining these standards, the 1-hr ozone standard will continue to apply in nonattainment areas (EPA 1997b:38855). For particulate matter, the current PM_{10} annual standard is retained, and two $PM_{2.5}$ standards are added. These standards are set at a 15-Fg/m^3 3-year annual arithmetic mean based on community-oriented monitors and a 65 Fg/m^3 3-year average of the 98th percentile of 24-hr concentrations at population-oriented monitors. The revised 24-hr PM_{10} standard is based on the 99th percentile of 24-hr concentrations. The existing PM_{10} standards will continue to apply in the interim period (EPA 1997c:38652).
Source: DOE 1996f:4-127–4-133; EPA 1997a; TNRCC 1997a, 1997b.

spray booths, miscellaneous laboratories, and other small operations are allowed under TNRCC standard exemptions. The explosive-burning operation is allowed under the TNRCC hazardous waste permit (DOE 1997c:21, 22).

With the exception of thermal treatment of high explosives at the burning ground, most stationary sources of nonradioactive atmospheric releases are fume hoods and building exhaust systems, some of which have HEPA filters for control of particulate emissions. Table 3–27 presents the ambient air concentrations attributable to sources at Pantex, which are based on emissions for the year 1993. These emissions were modeled using meteorological data from 1988 (DOE 1996f:4-123) and represent maximum output conditions. Actual annual emissions for some pollutants are somewhat less than these levels, and the estimated concentrations bound the actual Pantex contribution to ambient levels. Only those pollutants that would be emitted for any of the surplus plutonium disposition alternatives are presented. Additional information on ambient air quality at Pantex and detailed information on emissions of other pollutants at Pantex are discussed in the *Final EIS for the Continued Operation of Pantex* (DOE 1996f:4-117–4-135, B-3–B-61) and the 1996 *Environmental Report for Pantex Plant* (DOE 1997c:21, 22, 78–84). Concentrations of nonradiological air pollutants shown in Table 3–27 are in compliance with applicable regulations or are below applicable health effects-screening levels, the concentration of hazardous air pollutants determined by TNRCC to have minimal effect on human health and the environment.

Measurements of PM_{10} and various volatile organic compounds are made at Pantex. During 1993, only one 24-hr PM_{10} measurement exceeded the NAAQS level, while in 1994 the PM_{10} NAAQS level was exceeded 1 day in January and 1 day in June. Windblown dust is indicated as a major contributor to some of these exceedances. The concentrations of carbon monoxide, sulfur dioxide, and nitrogen dioxide from Pantex—combined with those from background (non-Pantex) sources—are expected to be in compliance with the ambient air quality standards. Measured concentrations of 1-2-dibromoethane exceeded the effects-screening levels once in 1995. However, monitoring in the last quarter of 1995 and 1996 showed that all organic compounds measured were below their respective effects-screening levels (DOE 1996f:4-121–4-123; M&H 1997:8, 12, 35–37). 1-2-dibromoethane is not emitted at Pantex. The air quality monitoring program is described in the annual site environmental monitoring reports (DOE 1997c).

Annual PM_{10} measured concentrations during 1995 were less than 24 Fg/m^3 at all monitoring locations, and except one measurement of 170 Fg/m^3 during a grass fire, 24-hr PM_{10} measured concentrations were below 129 Fg/m^3 (TNRCC 1997c:13–15).

3.4.1.1.2 Proposed Facility Location

The meteorological conditions described for Pantex are considered to be representative of the Zone 4 West area. Primary sources of pollutants in Zone 4 West include a standby diesel electric generator, drum sampling, and bulk handling of chemicals (DOE 1996f:B-10–B-29).

3.4.1.2 Noise

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.

3.4.1.2.1 General Site Description

Major noise emission sources within Pantex include various industrial facilities, equipment, and machines (e.g., cooling systems, transformers, engines, pumps, boilers, steam vents, construction and materials-handling equipment, vehicles), as well as small arms firing, alarms, and explosives detonation. Most Pantex industrial

facilities are far enough from the site boundary that noise levels from these sources at the boundary are barely distinguishable from background noise. However, some noise from explosives detonation can be heard at residences north of the site, and small arms weapons firing can be heard at residences to the west (DOE 1996a:3-153, 1996f:4-161–4-170).

The acoustic environment along the Pantex boundary and at nearby residences away from traffic noise is typical of a rural location. The day-night average sound levels are in the range, 35 to 50 dBA, that is typical of rural areas (EPA 1974: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 (M&H 1996a:11-1–11-19). Traffic is the primary source of noise at the site boundary and at residences near roads. Traffic noise is expected to dominate sound levels along major roads in the area, such as U.S. Route 60. The residents most likely to be affected by noise from plant traffic along Pantex access routes are those living along Farm-to-Market (FM) 2373 and FM 683 (DOE 1996a:3-153).

Measurements of equivalent sound levels for traffic noise and other sources along the roads bounding Pantex are 53 to 62 dBA for FM 2373 at about 400 m (1300 ft) from the road; 51 to 58 dBA for FM 293 at about 70 m (230 ft); 44 to 65 dBA for FM 683 at about 40 m (130 ft); and 51 dBA for U.S. Route 60 at about 225 m (740 ft). These levels are based on a limited number of 30-min samples taken during peak and offpeak traffic periods; mostly at locations within the site boundary (M&H 1996a:11-11–11-15). The levels represent the range of daytime traffic noise levels at residences near the site.

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 local governments have established any regulations that specify acceptable community noise levels applicable to Pantex (DOE 1996a:F-32).

The EPA guidelines for environmental noise protection recommend an average day-night sound level of 55 dBA as sufficient to protect the public from the effects of broadband environmental noise in typically quiet outdoor and residential areas (EPA 1974:29). Land-use compatibility guidelines adopted by the Federal Aviation Administration and the Federal Interagency Committee on Urban Noise indicate that yearly day-night average sound levels less than 65 dBA are compatible with residential land uses and levels up to 75 dBA are compatible with residential uses if suitable noise reduction features are incorporated into structures (DOT 1995). It is expected that for most residences near Pantex, the day-night average sound level is less than 65 dBA and is compatible with the residential land use.

3.4.1.2.2 Proposed Facility Location

No distinguishing noise characteristics of Zone 4 West have been identified. Zone 4 West is far enough—1.8 km (1.1 mi)—from the site boundary that noise levels from the facilities are barely distinguishable from background levels.

3.4.2 Waste Management

Waste management includes minimization, characterization, treatment, storage, transportation, and disposal of waste generated from ongoing DOE 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.

3.4.2.1 Waste Inventories and Activities

Pantex manages the following types of waste: LLW, mixed LLW, hazardous, and nonhazardous. TRU waste and mixed TRU waste are not normally generated and no HLW is currently generated at Pantex. Waste generation rates and the inventory of stored waste from activities at Pantex are provided in Table 3–28. Table 3–29 summarizes Pantex waste management capabilities. More detailed descriptions of the waste management system capabilities at Pantex are included in the *Storage and Disposition PEIS* (DOE 1996a:3-180–3-183, E-49–E-62) and the *Final EIS for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapons Components* (DOE 1996f:4-229).

Table 3–28. Waste Generation Rates and Inventories at Pantex

Waste Type	Generation Rate (m^3/yr)	Inventory (m^3)
TRU[a]		
Contact handled	0	0[b]
Remotely handled	0	0
LLW	139	208
Mixed LLW	24[c]	135
Hazardous	486[c,d]	153[e,f]
Nonhazardous		
Liquid	473,125[g]	NA[f]
Solid	8,007[c]	311[e,f,h]

[a] Includes mixed TRU waste.
[b] DOE 1997d:1-2.
[c] DOE 1997c:19.
[d] Includes TSCA-regulated wastes.
[e] DOE 1996f:4-233.
[f] Generally, hazardous and nonhazardous wastes are not held in long-term storage.
[g] King 1997a.
[h] Largely composed of asbestos waste.

Key: LLW, low-level waste; NA, not applicable; TRU, transuranic; TSCA, Toxic Substances Control Act.
Source: DOE 1996e:15, 16, except as notes.

EPA placed Pantex on the National Priorities List on May 31, 1994. Currently, environmental restoration activities are conducted in compliance with CERCLA and a RCRA permit issued in April 1991, and modified in February 1996. Environmental restoration activities are expected to be completed in 2000 (DOE 1996a:3-180). More information on regulatory requirements for waste disposal is provided in Chapter 5.

3.4.2.2 Transuranic and Mixed Transuranic Waste

Pantex does not generate or manage TRU waste as a result of normal operations, although there are procedures in place to manage TRU waste if it is generated. The small quantity of TRU waste (<1 m^3) that was stored in Building 12-24 was moved to LANL pending disposal at WIPP (DOE 1997d:1-2).

3.4.2.3 Low-Level Waste

Compactible solid LLW is processed at the LLW Compactor and stored along with the noncompactible materials for shipment to the Nevada Test Site (NTS), where most LLW is disposed of, or to a commercial vendor. Some liquid LLW has been solidified, but more development is required in this area. Much liquid

Table 3–29. Waste Management Capabilities at Pantex

			Applicable Waste Type					
Facility Name/Description	**Capacity**	**Status**	**TRU**	**Mixed TRU**	**LLW**	**Mixed LLW**	**Haz**	**Non-Haz**
Treatment Facility (m^3/yr)								
11-09 South - Scintillation Vial Crusher/Segregator	Variable[a]	Online[b]			X			
11-09 South - Sort/Segregation and Decontamination Activities	Variable[a]	Online[b]			X	X		
11-09 South - Fluorescent Bulb Crusher	Variable[a]	Online[b]					X	
12-17 - Evaporator for Tritiated Water	Campaign	Online			X			
12-19 East - Rotary Evaporator Vacuum Distillation Units (2)	Campaign	Online						X
12-19 East - Fractional Distillation Unit	Campaign	Online						X
12-19 East - HE Precipitation Process	Campaign	Online						X
12-42 - Compactor/Drum Crusher	Variable[a]	Online[b]			X			
16-18 - HWTPF	750	Planned for 1999			X	X	X	
16-18 - HWTPF Waste Compacting	90	Planned for 1999			X	X	X	X
16-18 - HWTPF Drum Crushing	208	Planned for 1999			X	X	X	X
16-18 - HWTPF Wastewater Evaporation System	45	Planned for 1999			X			
16-18 - HWTPF Misc Drum Operations (including neutralization and filtration)	Various	Planned for 1999			X	X	X	
16-18 - HWTPF Drum Rinsing System	45	Planned for 1999					X	
16-18 - HWTPF Fluorescent Bulb Crusher	12	Planned for 1999					X	
16-18A - Solvent Recovery Unit	348	Planned for 1999					X	
16-18A - Scintillation Vial Crushing	90	Planned for 1999			X			X
Burning Ground Thermal Processing Units	Variable[c]	Online				X	X	
Wastewater Treatment Facility	946,250	Online						X

Facility Name/Description	Capacity	Status	Applicable Waste Type					
			TRU	Mixed TRU	LLW	Mixed LLW	Haz	Non-Haz
Storage Facility (m^3)								
11-07A & B Pads - Container Storage Areas	402	Online			X	X	X	X
11-07 North Pad - Container Storage Unit	125	Online			X	X	X	X

Table 3–29. Waste Management Capabilities at Pantex (Continued)

Facility Name/Description	Capacity	Status	Applicable Waste Type					
			TRU	Mixed TRU	LLW	Mixed LLW	Haz	Non-Haz
11-09 North Building - Container Storage Area	379	Online			X	X	X	X
16-16 Building - Hazardous Waste Staging Facility	1,047	Online			X	X	X	X
Disposal Facility (m^3)								
Construction Debris Landfill (Zone 10)	21,208	Online						X

[a] Capacity included in HWTPF.

[b] Unit will move to HWTPF when operational in 1999.

[c] Permit limitations are per burning event.

Key: Haz, hazardous; HE, high explosives; HWTPF, Hazardous Waste Treatment and Processing Facility; LLW, low-level waste; TRU, transuranic.

Source: King 1997b; Lemming 1998; M&H 1997:28.

LLW is currently being evaporated. The remaining liquid LLW is being stored on the site awaiting a treatment process (Jones 1999).

Pantex is presently approved to ship seven LLW streams to NTS for disposal. Previous approvals of two waste streams were deactivated due to changes in the characterization of the wastes, but the requests for approval are being updated and reviewed and approval is expected. Requests for the approval of two additional waste streams are being prepared for submittal, and several other waste streams are being studied and considered for submittal. These wastes are currently stored on the site. Soil contaminated with depleted uranium has been disposed of at a commercial facility, and the possibility for disposal of other LLW at commercial facilities is being pursued where technically and economically advisable. Radioactively contaminated classified weapon components that cannot be demilitarized and sanitized are sent to the classified LLW repository at NTS (Jones 1999).

3.4.2.4 Mixed Low-Level Waste

Pantex treats mixed LLW in three areas: the Burning Ground, Building 11-9, and Building 12-17 (King 1997b). The Burning Ground is an open-burning area where explosives, explosive-contaminated waste, and explosive-contaminated spent solvents are burned. A large-volume reduction is attained by this treatment, and some wastes are rendered nonhazardous due to elimination of the high-explosive reactivity hazard (DOE 1996a:E-50). Building 11-9 in Zone 11 is permitted for the treatment and processing of mixed LLW and hazardous waste in tanks and containers (DOE 1996f:4-236).

Pantex has developed the *Pantex Plant Federal Facility Compliance Act Compliance Plan* to provide mixed waste treatment capability for all mixed waste streams in accordance with the FFCA of 1992 (DOE 1996a:3-180). Currently, some mixed LLW is stored on the site until it can be profiled and accepted by offsite treatment and disposal facilities, in accordance with the Pantex site treatment plan (DOE 1997c:sec. 2.3.1). The Hazardous Waste Treatment and Processing Facility is being planned to treat mixed waste (DOE 1996a:E-50).

3.4.2.5 Hazardous Waste

Pantex stores some hazardous waste on the site. Most hazardous waste generated at Pantex is shipped off the site for recycle, treatment, or disposal at commercial facilities. High explosives, high-explosive contaminated materials, and high-explosive contaminated solid wastes are burned under controlled conditions at the Burning Ground. Ash, debris, and residue resulting from this burning are transported off the site for approved disposal at a commercial RCRA-permitted facility (DOE 1996a:3-183, E-51). Polychlorinated biphenyls waste is transported to offsite permitted facilities for treatment and disposal (DOE 1996f:4-238).

3.4.2.6 Nonhazardous Waste

Management of solid waste is regulated by TNRCC. Nonhazardous waste generated at Pantex falls into Texas Class 1 or Class 2 designation. Some solid waste (inert and insoluble materials like certain scrap metals, bricks, concrete, glass, dirt, and certain plastics and rubber items that are not readily degradable) is designated as Class 2 nonhazardous waste and is disposed on the site in the Construction Debris Landfill in Zone 10. The onsite landfill is approved for both Class 2 and Class 3 wastes. The remainder of the Class 2 nonhazardous waste generated at Pantex is sanitary waste such as cafeteria and lunchroom waste, paper towels, and office waste. Most of this waste is disposed off the site at permitted landfills (such as the city of Amarillo landfill), although some goes to offsite commercial incinerators (DOE 1997c:sec. 2.3.1).

Class 1 nonhazardous waste (such as asbestos), though not hazardous by EPA's definition relative to RCRA, is handled in much the same manner as hazardous waste and is sent to offsite treatment or disposal facilities (DOE 1997c:sec. 2.3.1). Medical waste is dispositioned through a commercial vendor who picks up and transports the waste (DOE 1996f:4-238).

Sanitary sewage and some pretreated industrial wastewater are treated by the Wastewater Treatment Facility and discharged to Playa 1 (DOE 1996f:4-238). The treated effluent from the system either evaporates or infiltrates into the ground. Upgrades to the facility and associated collection/conveyance system will help to ensure that effluent limitations are met. Included in this project is the upgrade of the existing sewage treatment lagoon, repair and replacement of deteriorated sewer lines, construction of a closed system to eliminate the use of open ditches for conveyance of industrial wastewater discharges, and improvements to the plant storm-water management system (DOE 1996a:3-183, E-51). Conceptual design of the Wastewater Treatment Facility was completed on January 26, 1998, and the Title I detailed design was scheduled to be completed by June 30, 1999. Award of the actual facility construction contract is scheduled for January 31, 2001; completion of construction of all treatment facility upgrades is scheduled for November 30, 2003 (DOE 1999a).

An environmental assessment (EA) was recently completed for the wastewater treatment plant upgrade (DOE 1999d) and a FONSI was issued (DOE 1999e). As selected in the FONSI, the project to upgrade the existing Wastewater Treatment Facility will essentially involve the construction of a new, zero-discharge facility south of the current facility and outside the 100-year floodplain of Playa 1. Specifically, two new lagoons will be constructed, one serving as a facultative treatment lagoon and the second as an irrigation water storage reservoir and alternate treatment lagoon. The existing Wastewater Treatment Facility lagoon will be retained as a supplemental storage facility for treated wastewater effluent.

Beginning in 2003, instead of being discharged to Playa 1, treated effluents will be disposed of via land application for the irrigation of crops in cooperation with the Texas Tech University Research Farm. Either a subsurface flow system, a center-pivot system, or an overland flow irrigation system will be used to apply effluents (DOE 1999d, 1999e).

3.4.2.7 Waste Minimization

The goals of the Pantex pollution prevention and waste minimization program are to minimize the volume of waste generated to the extent that it is technologically and economically practical; reduce the hazard of waste through substitution or process modification; minimize contamination of real property and facilities; minimize exposure and associated risk to human health and the environment; and ensure safe, efficient, and compliant long-term management of all wastes (DOE 1996a:3-180).

Although an overall increase in waste generation of 49 percent occurred in 1996, this was largely a result of the removal of contaminated soil from ditches as part of the environmental restoration program. In fact, from 1987 to 1996, the generation of routine hazardous waste decreased by more than 99 percent. The generation of other waste types has also been reduced. The goal of reducing the generation of mixed LLW by 50 percent from 1992 levels has already been met. Another goal is to halve the generation of LLW and State-regulated (Class 1) wastes by 1999 (DOE 1997c:sec. 3.5). Pantex also participates in the Clean Texas 2000 pollution prevention program and has committed to a 50 percent reduction in 1987 chemical releases and hazardous waste generation by the year 2000 (DOE 1996f:4-232). Currently, telephone directories, paper, certain plastics, and some steel and aluminum cans are being recycled (DOE 1996a:E-51).

3.4.2.8 Preferred Alternatives From the WM PEIS

Preferred alternatives from the WM PEIS (DOE 1997a:summary, 109) are shown in Table 3–30 for the four waste types analyzed in this SPD EIS. A decision on the future management of these wastes could result in the construction of new waste management facilities at Pantex, and the closure of other facilities. Decisions on the various waste types are expected to be announced in a series of RODs to be issued on this WM PEIS. In fact, the TRU waste ROD was issued on January 20, 1998 (DOE 1998a), with the hazardous waste ROD issued on August 5, 1998 (DOE 1998b). The TRU waste ROD states that DOE will develop and operate mobile and fixed facilities to characterize and prepare TRU waste for disposal at WIPP. Each DOE site that has, or will generate, TRU waste will, as needed, prepare and store its TRU waste on the site. The hazardous waste ROD states that most DOE sites will continue to use offsite facilities for the treatment and disposal of major portions of the nonwastewater hazardous waste, with ORR and SRS continuing to treat some of their own hazardous waste on the site in existing facilities where this is economically favorable. More detailed information on DOE's alternatives for the future configuration of waste management facilities at Pantex is presented in the WM PEIS, and the hazardous waste and TRU waste RODs.

Table 3–30. Preferred Alternatives From the WM PEIS

Waste Type	Preferred Action
TRU and mixed TRU	DOE prefers treatment and storage of Pantex TRU waste at LANL.[a]
LLW	DOE prefers to treat Pantex LLW on the site. DOE prefers to ship Pantex LLW to one of two or three regional disposal sites.
Mixed LLW	DOE prefers to treat mixed LLW generated at Pantex on the site consistent with Pantex's site treatment plan. DOE prefers to ship Pantex mixed LLW to one of two or three regional disposal sites.
Hazardous	DOE prefers to continue to use commercial facilities for hazardous waste treatment.[b]

[a] ROD for TRU waste (DOE 1998a) states that "each of the Department's sites that currently has or will generate TRU waste will prepare and store its TRU waste on site. . . ." The ROD did not specifically address TRU waste generated at Pantex, since there is currently no TRU waste in inventory at Pantex.

[b] ROD for hazardous waste (DOE 1998b) selected the preferred alternative at Pantex.

Key: LANL, Los Alamos National Laboratory; LLW, low-level waste; TRU, transuranic.

Source: DOE 1997a:summary, 26, 109.

3.4.3 Socioeconomics

Statistics for employment and regional economy are presented for the REA as defined in Appendix F.9, which encompasses 32 counties surrounding Pantex in Texas and New Mexico. Statistics for population, housing, community services, and local transportation are presented for the ROI, a three-county area (in Texas) in which 93.8 percent of all Pantex employees reside as shown in Table 3–31. In 1997, Pantex employed 2,944 persons (about 1.3 percent of the REA civilian labor force) (King 1997a).

Table 3–31. Distribution of Employees by Place of Residence in the Pantex Region of Influence, 1997

County	Number of Employees	Total Site Employment (Percent)
Randall	1,629	55.3
Potter	965	32.8
Carson	167	5.7
ROI total	2,761	93.8

Source: King 1997a.

3.4.3.1 Regional Economic Characteristics

Selected employment and regional economy statistics for the Pantex REA are summarized in Figure 3–18. Between 1990 and 1996, the civilian labor force increased 11.6 percent to 234,072. In 1996, the unemployment rate in the REA was 4.6 percent, which was lower than the 5.6 percent unemployment rate in Texas and the 8.1 percent unemployment rate in New Mexico (DOL 1999). In 1995, government activities represented the largest sector of the employment in the REA (21.9 percent). This was followed by retail trade (19.6 percent) and services (18.8 percent). The totals for these employment sectors in Texas were 18.0 percent, 18.7 percent, and 24.7 percent, respectively. The totals for these employment sectors in New Mexico were 22 percent, 20.3 percent, and 26.7 percent, respectively (DOL 1997).

3.4.3.2 Population and Housing

In 1996, the ROI population totaled 212,729. Between 1990 and 1996, the ROI population increased 9.6 percent compared with the 12.2 percent increase in Texas (DOC 1997). Between 1980 and 1990, the number of housing

units in the ROI increased by about 15.8 percent, compared with the 26.3 percent increase in Texas. The total number of housing units within the ROI for 1990 was 83,590 (DOC 1994). The 1990 homeowner vacancy rate for the ROI, 3.3 percent, was similar to the Texas rate of 3.2 percent. The renter vacancy rate, 14.2 percent, was also similar to Texas' 13 percent (DOC 1990a). Population and housing trends in the Pantex ROI are summarized in Figure 3–19.

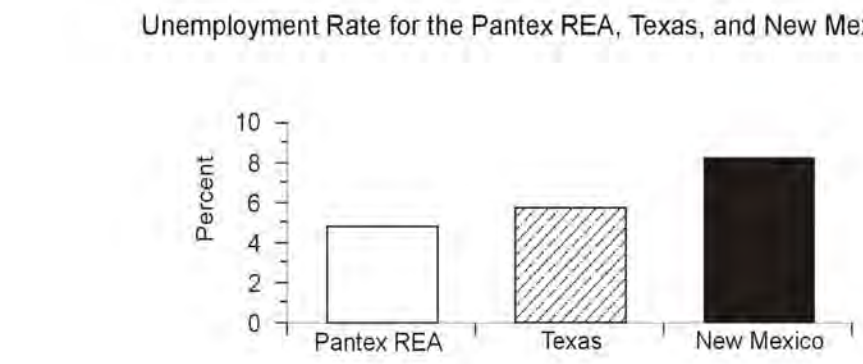
3.4.3.3 Community Services

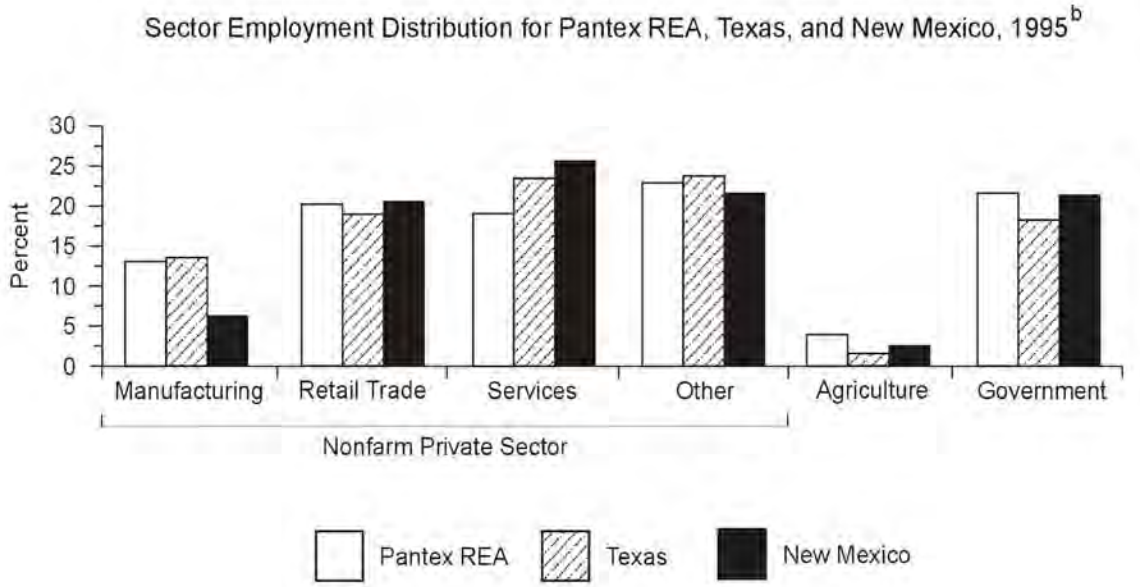
3.4.3.3.1 Education

Eight school districts provide public education in the Pantex ROI. As shown in Figure 3–20, school districts were operating between 56 and 100 percent of capacity in 1997. In 1997, the average student-to-teacher ratio for the ROI was 15:1 (Nemeth 1997a). In 1990, the average student-to-teacher ratio for Texas was 11.3:1 (DOC 1990b; 1994).

3.4.3.3.2 Public Safety

In 1997, a total of 542 sworn police officers were serving the ROI. The 1997 ROI average officer-to-population ratio was 2.5 officers per 1,000 persons (Nemeth 1997b). This compares with the 1990 State average of 2.0 officers per 1,000 persons (DOC 1990b). In 1997, 487 paid and volunteer firefighters provided fire protection services to the Pantex ROI. The 1997 average ROI firefighter-to-population ratio was 2.3 firefighters per 1,000 persons (Nemeth 1997b). This compares with the1990 State average of 0.9 firefighters per





[a]DOL 1999.
[b]DOL 1997.

REA Regional economic area

Figure 3–18. Employment and Local Economy for the Pantex Regional Economic Area and the States of Texas and New Mexico

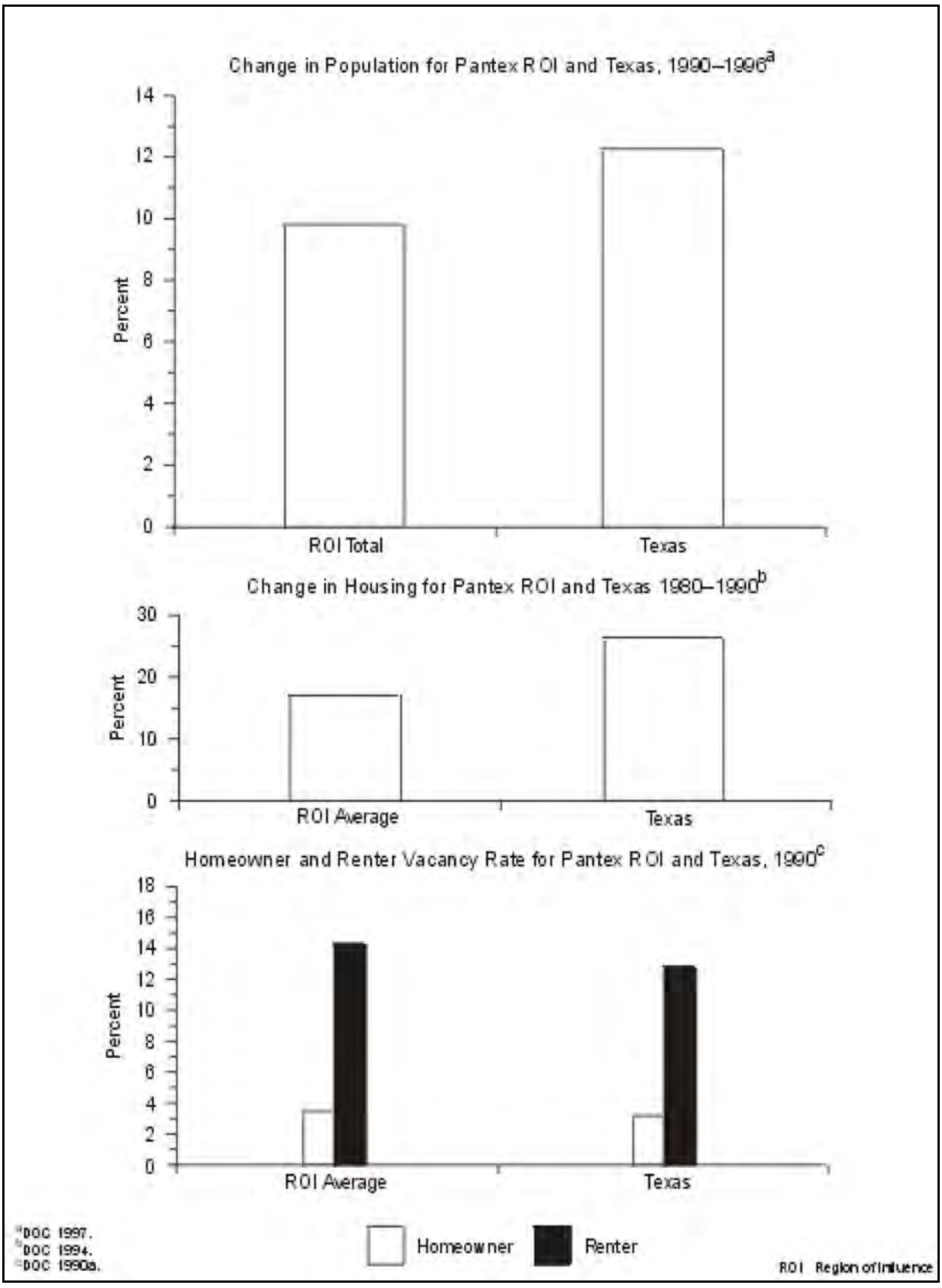


Figure 3–19. Population and Housing for the Pantex Region of Influence and the State of Texas

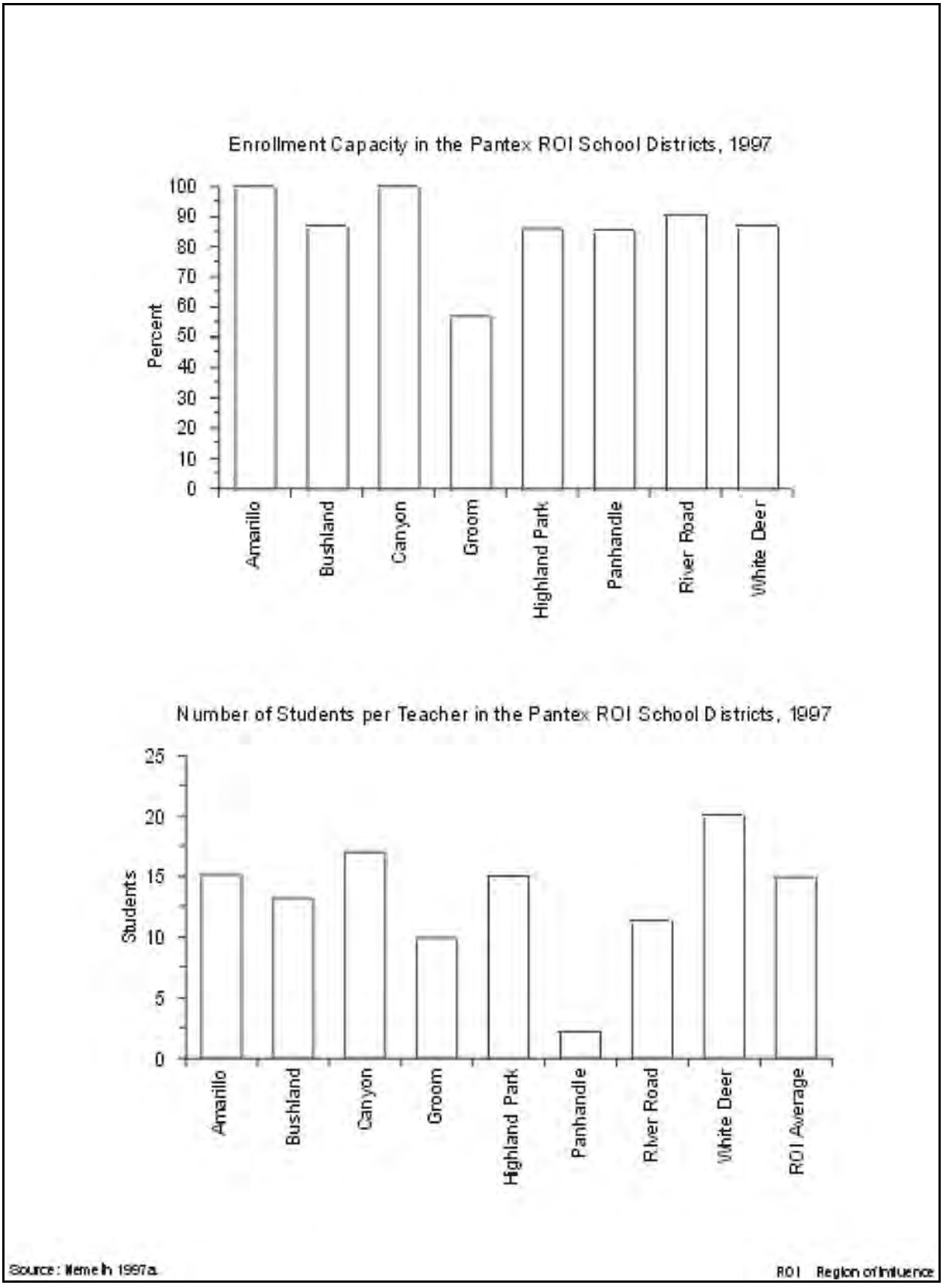


Figure 3–20. School District Characteristics for the Pantex Region of Influence

1,000 persons (DOC 1990b). Figure 3–21 displays the ratio of sworn police officers and firefighters to the population for the Pantex ROI.

3.4.3.3.3 Health Care

In 1996, a total of 531 physicians served the ROI. The 1996 average physician-to-population ratio in the ROI of 2.5 physicians per 1,000 persons compares with the 1996 State average of 2.2 physicians per 1,000 persons (Randolph 1997). In 1997, six hospitals served the three-county ROI. The 1997 hospital bed-to-population ratio was 5.9 beds per 1,000 persons in the ROI (Nemeth 1997c). This compares with the 1990 State average of 3.4 beds per 1,000 persons (DOC 1996:128). Figure 3–21 displays the ratio of hospital beds and physicians to the population for the Pantex ROI.

3.4.3.4 Local Transportation

Vehicular access to Pantex is provided by FM 683 to the west and FM 2373 to the east. Both roads connect with FM 293 to the north and U.S. Route 60 to the south (see Figure 2–4). Four road segments in the ROI could be affected by route disposition alternatives: I–27 from Local Route 335 at Amarillo to I–40 at Amarillo and FM 683 from U.S. Route 60 to FM 293. The third is FM 2373 from I–40 to U.S. Route 60. The fourth is FM 2373 from U.S. Route 60 to FM U.S. Route 60 (DOE 1996a).

Aside from routine minor preventive maintenance paving, there was one planned road improvement project in 1998 that could affect access onto the Pantex site. This includes the construction of a bridge along FM 1912 over U.S. Route 60. There are also long-range plans to build a bridge at the intersection of FM 2373 and U.S. Route 60. Both of these projects are not expected to be initiated until the year 2000 or beyond (Nipp 1997). Even without these improvements, the road system is more than adequate for current Pantex workloads.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 that 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 (DOE 1996a).

3.4.4 Existing Human Health Risk

Public and occupational health and safety issues include the determination of potentially adverse effects on human health that result from acute and chronic exposures to ionizing radiation and hazardous chemicals.

3.4.4.1 Radiation Exposure and Risk

3.4.4.1.1 General Site Description

Major sources and levels of background radiation exposure to individuals in the vicinity of Pantex are shown in Table 3–32. Annual background radiation doses to individuals are expected to remain constant over time. The total dose to the population, in terms of person-rem, changes as the population size changes. Background radiation doses are unrelated to Pantex operations.

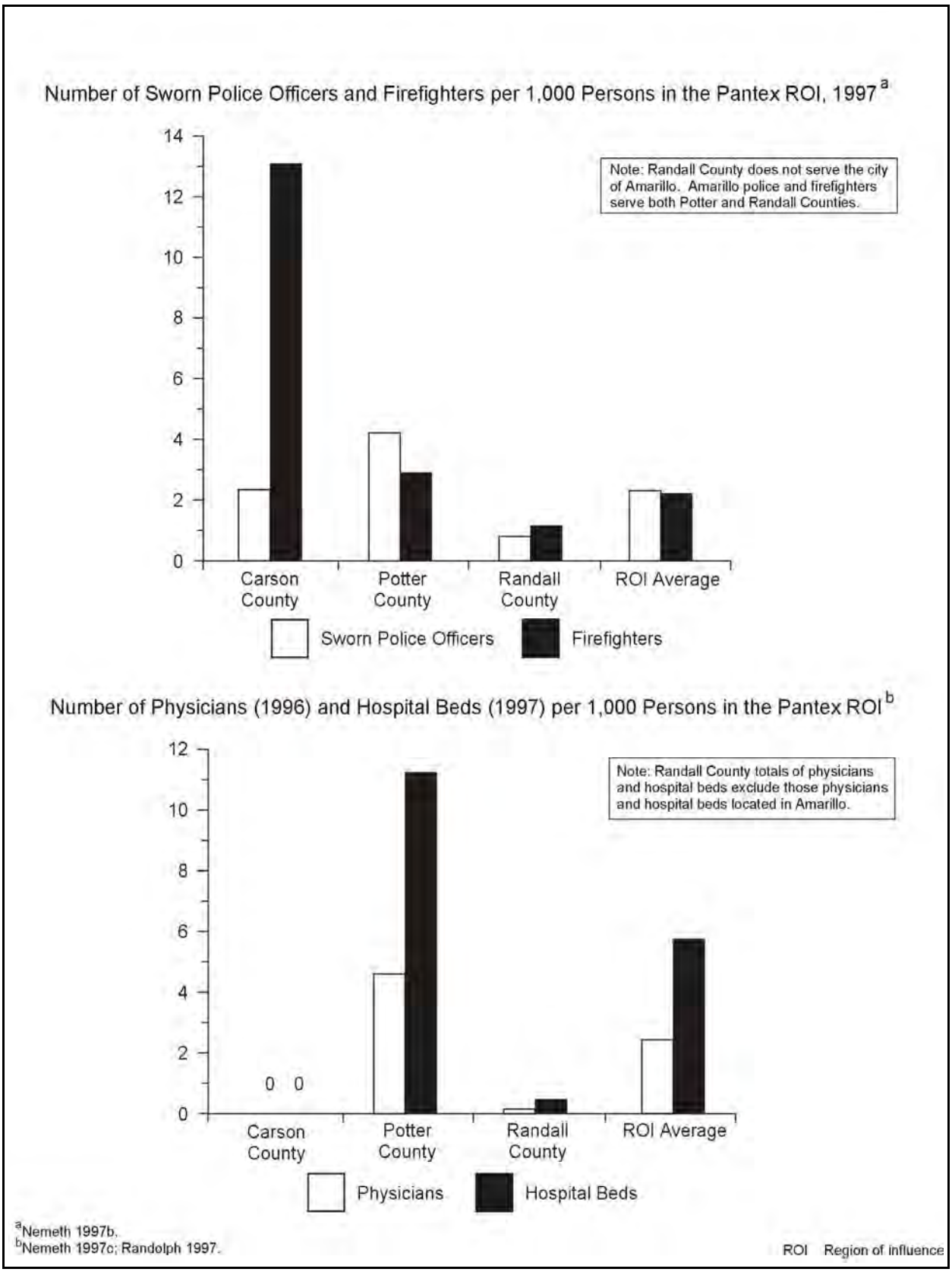


Figure 3–21. Public Safety and Health Care Characteristics for the Pantex Region of Influence

Table 3–32. Sources of Radiation Exposure to Individuals in the Pantex Vicinity Unrelated to Pantex Operations

Source	Effective Dose Equivalent (mrem/yr)
Natural background radiation	
Cosmic and external terrestrial radiation[a]	93
Internal terrestrial radiation[b]	39
Radon in homes (inhaled)[b]	200[c]
Other background radiation[b]	
Diagnostic x rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	397

[a] DOE 1997c:65.

[b] NCRP 1987:11, 40, 53.

[c] An average for the United States.

Releases of radionuclides to the environment from Pantex operations provide another source of radiation exposure to people in the vicinity of Pantex. Types and quantities of radionuclides released from Pantex operations in 1996 are listed in the *1996 Environmental Report for Pantex Plant* (DOE 1997c:64). Doses to the public resulting from these releases are given in Table 3–33. These doses fall within radiological limits per DOE Order 5400.5 (DOE 1993a:II-1–II-5) and are much lower than those of background radiation.

Table 3–33. Radiation Doses to the Public From Normal Pantex Operations in 1996 (Total Effective Dose Equivalent)

	Atmospheric Releases		Liquid Releases		Total	
Members of the Public	**Standard[a]**	**Actual**	**Standard[a]**	**Actual**	**Standard[a]**	**Actual**
Maximally exposed individual (mrem)	10	8.8×10^{-5}	4	0	100	8.8×10^{-5}
Population within 80 km (person-rem)[b]	None	2.1×10^{-3}	None	0	100	2.1×10^{-3}
Average individual within 80 km (mrem)[c]	None	7.6×10^{-6}	None	0	None	7.6×10^{-6}

[a] The standards for individuals are given in DOE Order 5400.5 (DOE 1993a:II-1–II-5). As discussed in that order, the 10-mrem/yr limit from airborne emissions is required by the Clean Air Act, and the 4-mrem/yr limit is required by the Safe Drinking Water Act; for this SPD EIS, the 4-mrem/yr value is conservatively assumed to be the limit for the sum of doses from all liquid pathways. 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, as published in 58 FR 16268 (DOE 1993b:para. 834.7). If the potential total dose exceeds the 100-person-rem value, it is required that the contractor operating the facility notify DOE.

[b] About 275,000 in 1996.

[c] Obtained by dividing the population dose by the number of people living within 80 km (50 mi) of the site.

Source: DOE 1997c:65.

Using a risk estimator of 500 cancer deaths per 1 million person-rem (5×10^{-4} fatal cancer per person-rem) to the public (see Appendix F.10), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from Pantex operations in 1996 is estimated to be 4.4×10^{-11}. 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 Pantex operations is less than 5 in 100 billion. (It takes several to many years from the time of radiation exposure for a cancer to manifest itself.)

According to the same risk estimator, 1.1×10^{-6} excess fatal cancer is projected in the population living within 80 km (50 mi) of Pantex from normal operations in 1996. To place this number into perspective, it may be compared with the number of fatal cancers expected in the same population from all causes. The 1996 mortality rate associated with cancer for the U.S. population was 0.2 percent per year (Famighetti 1998:964). Based on this mortality rate, the number of fatal cancers expected to occur during 1996 from all causes in the population living within 80 km (50 mi) of Pantex was 550. This expected number of fatal cancers is much higher than the 1.1×10^{-6} fatal cancer estimated from Pantex operations in 1996.

Pantex workers receive the same dose as the general public from background radiation, but they also receive an additional dose from working in facilities with nuclear materials. Table 3–34 presents the average dose to the individual worker and the cumulative dose to all workers at Pantex from operations in 1996. These doses fall within the radiological regulatory limits of 10 CFR 835 (DOE 1995a:para. 835.202). According to a risk estimator of 400 fatal cancers per 1 million person-rem among workers[6] (Appendix F.10), the number of projected fatal cancers among Pantex workers from normal operations in 1996 is 0.011.

Table 3–34. Radiation Doses to Workers From Normal Pantex Operations in 1996 (Total Effective Dose Equivalent)

	Onsite Releases and Direct Radiation	
Occupational Personnel	**Standard[a]**	**Actual**
Average radiation worker (mrem)	None[b]	8.7
Total workers (person-rem)[c]	None	28

[a] The radiological limit for an individual worker is 5,000 mrem/yr (DOE 1995a:para. 835.202). However, DOE's goal is to maintain radiological exposure as low as is reasonably achievable. It has therefore established an administrative control level of 2,000 mrem/yr (DOE 1994a:2-3); the site must make reasonable attempts to maintain individual worker doses below this level.

[b] No standard is specified for an "average radiation worker"; however, the maximum dose that this worker may receive is limited to that given in footnote "a."

[c] About 3,160 in 1996 of which approximately 2,400 were badged.

Source: M&H 1997.

A more detailed presentation of the radiation environment, including background exposures and radiological releases and doses, is presented in the *1996 Environmental Report for Pantex Plant* (DOE 1997c). In addition, the concentrations of radioactivity in various environmental media (including air, water, and soil) in the site region (on and off the site) are presented in that same report.

3.4.4.1.2 Proposed Facility Location

External radiation doses and concentrations of gross alpha and plutonium in air have been measured in Zone 4. In 1996, the annual dose in Zone 4 was about 100 mrem. This is the same as measured at the offsite control location, which indicates that there is no additional dose to workers above background. In that same year, the

[6] The risk estimator for workers is lower than the estimator for the public because of the absence from the workforce of the more radiosensitive infant and child age groups.

Zone 4 concentration in air of plutonium 239/240 was 3.2×10^{-7} pCi/m^3. This value was about one-third less than that measured at the offsite locations (DOE 1997c:67, 77, 79).

3.4.4.2 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 through which people may come in contact with hazardous chemicals (e.g., surface water during swimming, soil through direct contact, or food). Hazardous chemicals can cause cancer and noncancer health effects. The baseline data for assessing potential health impacts from the chemical environment are addressed in Section 3.4.1.

Effective administrative and design controls that decrease hazardous chemical releases to the environment and help achieve compliance with permit requirements (e.g., air emissions and NPDES permit requirements) contribute to minimizing health impacts on the public. The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts on the public may occur via inhalation of air containing hazardous chemicals released to the atmosphere during normal Pantex operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water or by direct exposure, are lower than those from the inhalation pathway.

Baseline air emission concentrations and applicable standards for hazardous chemicals are addressed in Section 3.4.1. The baseline concentrations are estimates of the highest existing offsite concentrations and represent the highest concentrations to which members of the public could be exposed. All annual concentrations are in compliance with applicable guidelines and regulations. Information on estimating the health impacts of hazardous chemicals is presented in Appendix F.10.

Exposure pathways to Pantex workers during normal operations may include the inhalation of contaminants in the workplace atmosphere and direct contact with hazardous materials. The potential for health impacts varies among facilities and workers, and available information is insufficient for a meaningful estimate of impacts. However, workers are protected from workplace hazards through appropriate training, protective equipment, monitoring, substitution, and engineering and management controls. They 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 used in the operational processes ensures that these standards are not exceeded. Additionally, DOE requires that conditions in the workplace be as free as possible from recognized hazards that cause, or are likely to cause, illness or physical harm. Therefore, workplace conditions at Pantex are substantially better than required by standards.

3.4.4.3 Health Effects Studies

Only one cancer incidence and mortality study was conducted on the general population in communities surrounding Pantex for the period 1981 to 1992, and only one study of workers (employed between 1951 and 1978) has been done. There were no statistically significant increases in mortality among females in the general population during this period, but significant increases in prostate cancer mortality occurred among Potter County and Randall County males, and in leukemia mortality among Carson County males. No statistically significant increases in other types of cancer among males occurred during this period. Significantly fewer deaths were observed in the workforce than would be expected judging from U.S. death rates for cancer, arteriosclerotic heart disease, and digestive diseases. No specific causes of death occurred more frequently than expected. Workers were reported to show a nonstatistically significant excess of brain cancer and leukemia in the study conducted; the small number of cases could be attributed to chance alone. For a more detailed description of the studies reviewed and the findings, and for a discussion of the epidemiologic surveillance program

implemented by DOE to monitor the health of current Pantex workers, refer to Appendix M.4.5 of the *Storage and Disposition PEIS* (DOE 1996a).

3.4.4.4 Accident History

In 1989, during a weapon disassembly and retirement operation, a release of tritium in the assembly cell occurred. Four workers received negligible doses, and a fifth, a somewhat higher, but still low dose of 1.4 mrem. No other incidents involving the accidental release of radioactivity from Pantex have taken place in more than 30 years.

3.4.4.5 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 to most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program includes planning, preparedness, and response.

Pantex has an emergency management plan to protect life and property within the facility, the health and welfare of surrounding areas, and the defense interests of the nation during any credible emergency situation. Formal mutual assistance agreements have been made with the Amarillo fire department, the National Guard, and St. Anthony's Hospital. Under accident conditions, an emergency coordinating team of DOE and Pantex contractor management personnel would initiate the Pantex emergency plan and coordinate all onsite actions.

If offsite areas could be affected, the Texas Department of Public Safety would be notified immediately and would make emergency announcements to the public and local governmental agencies in accordance with Annex R of the *State of Texas Emergency Management Plan*. Pantex has Radiological Assistance Teams equipped and trained to respond to an accident involving radioactive contamination on or off the site. In addition, the Joint Nuclear Accident Coordination Center in Albuquerque, New Mexico, can be called on if needed to mobilize radiation emergency response teams from DOE, DoD, and other participating Federal agencies.

DOE has specified actions to be taken at all DOE sites to implement lessons learned from the emergency response to an accidental explosion at Hanford in May 1997. These actions and the timeframe in which they must be implemented are presented in Section 3.2.4.5.

3.4.5 Environmental Justice

Environmental justice concerns the environmental impacts that proposed actions may have on minority and low-income populations, and whether such impacts are disproportionate to those on the population as a whole in the potentially affected area. In the case of Pantex, the potentially affected area includes only parts of northwestern Texas.

The potentially affected area around Zone 4 West is defined by a circle with an 80-km (50-mi) radius centered at Pantex (lat. 35E20'0.4" N, long. 101E34'22.5" W). The total population residing within that area in 1990 was 266,004. The proportion of the population there that was considered minority was 19.1 percent. The same census data show that the percentage of minorities for the contiguous United States was 24.1, and for the State of Texas, 39.3 (DOC 1992).

Figure 3–22 illustrates the racial and ethnic composition of the minority population in the potentially affected area. At the time of the 1990 census, Hispanics were the largest minority group within that area, constituting 12.8 percent of the population. Blacks constituted about 4.2 percent, and Asians, about 1.3 percent. Native Americans were the smallest group, constituting about 0.8 percent (DOC 1992).

A breakdown of incomes in the potentially affected area is also available from the 1990 census data (DOC 1992). At that time, the poverty threshold was $9,981 for a family of three with one related child under 18 years of age. A total of 39,578 persons (15.2 percent of the total population) residing within the potentially affected area around Zone 4 West reported incomes below that threshold. Data obtained during the 1990 census also show that of

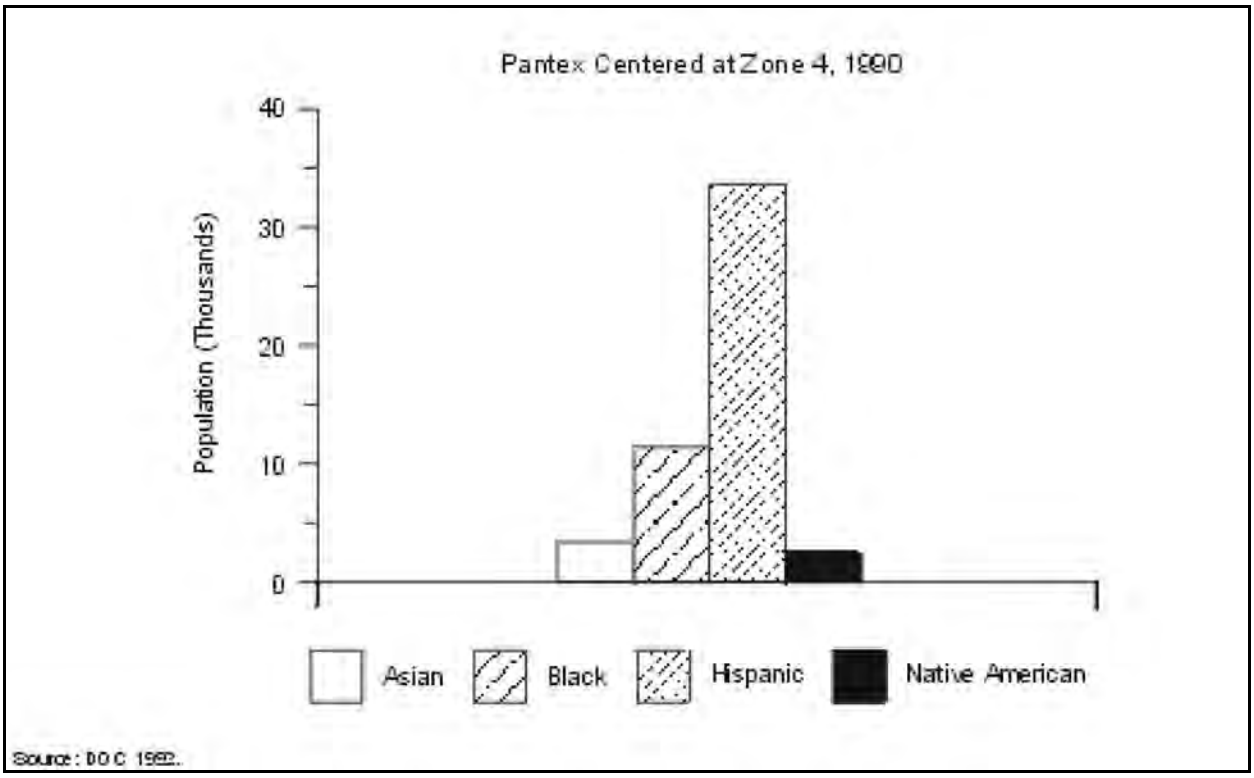


Figure 3–22. Racial and Ethnic Composition of Minorities Around Pantex

the total population of the contiguous United States, 13.1 percent reported incomes below the poverty threshold, and that Texas reported 18.1 percent.

3.4.6 Geology and Soils

Geologic resources are consolidated or unconsolidated earth materials, including 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.

3.4.6.1 General Site Description

Pantex is rather flat and includes four playas on DOE property and two playas on land leased from Texas Tech University (M&H 1996a:5-5). The playas are frequently dry, with clay bottoms and depths to about 9 m (30 ft)(DOE 1996a:3-165). (See Section 3.4.7.1 for additional information on these playas.) The primary surface deposits at Pantex are Pullman soils on the Southern High Plains surface and Randall soils in the playas (M&H 1996a:3-1).

The Pullman soils are the soil horizon in the uppermost section of the Quaternary-aged Blackwater Draw Formation. This formation consists of a sequence of buried soil horizons, the upper unit of mostly clay loam and caliche about 3 m (10 ft) thick and a lower unit of silty sand with caliche 10 to 24 m (30 to 80 ft) thick. The Blackwater Draw Formation overlies the Ogallala Formation (M&H 1996a:3-1).

| The Ogallala Formation of Tertiary Age regionally consists of alluvial sediments partly occupying paleovalleys,
| with eolian sediments capping paleouplands and most fluvial deposits. More specifically, the basal, paleovalley

fill materials consist of sands and gravels deposited in a high-energy fluvial environment along with fine sand and silt and laminated-to-massive clay resulting from overbank or floodplain deposition. Eolian sediments overlie and are interbedded with the fluvial deposits and consist of dune sand deposits as well as deposits ranging from fine sand to coarse silt thought to have been deposited as thin sand sheets and loess. Overall, a total of seven distinct lithofacies have been identified in the Ogallala Formation, including gravel; sand and gravel; fluvial sand; find sand and mud; laminated fine sand and silt; and laminated-to-massive clay, eolian sand, and fine sand to coarse silt (Gustavson 1996:1, 5, 17, 34, 48). The top of the formation is capped by the Caprock caliche. Depths to the base of the Ogallala vary considerably, from about 90 m (300 ft) at the southwest corner of the site to about 220 m (720 ft) at the northeast corner of the site (M&H 1996a:3-1). Underlying the Ogallala Formation are sedimentary rocks of the Triassic Dockum Group. This rock is as much as 30 m (100 ft) thick and consists of sandstone, siltstone, and mudstone. The portion of the Triassic Dockum Group near the northeastern corner of Pantex was eroded before the Ogallala was deposited directly on Permian strata (M&H 1996a:19). The Permian strata consist of deposits of salt, shale, limestone, argillaceous (clay-bearing) limestone, and dolomite. No economically viable geologic resources have been identified at Pantex (DOE 1996a:3-165).

Dissolution of salt beds within the Permian strata has resulted in sinkholes and fractures in nearby Armstrong and Hutchinson Counties in Texas. No sinkholes or fractures have been identified in Carson County, where the site is located. Recent work using shallow seismic data has determined that the structure beneath the playas at Pantex and adjacent areas shows the displacement of Ogallala strata. This displacement is attributed to the dissolution of underlying salt beds, an active geologic process in the region (DOE 1996a:3-165). In terms of the life of Pantex, the effects of that process are negligible (M&H 1997:19).

There are no capable faults in the vicinity of Pantex. A capable fault is one that has had movement at or near the ground surface at least once within the past 35,000 years or recurrent movement within the past 500,000-years (DOE 1996a:3-165). No tectonic faulting younger than late Permian is recognized at or near Pantex. An assessment of natural hazards at Pantex found three major subsurface faults and one minor surface fault. The subsurface faults range from 64 to 250 km (40 to 155 mi) in length and are 8 to 40 km (5 to 25 mi) from the plant site. The surface fault is estimated to be 6.4 km (4 mi) long and 32 km (20 mi) northwest of Pantex (M&H 1996a:3-8–3-10).

According to the Uniform Building Code, Pantex is on the boundary zone between Seismic Zones 0 and 1, meaning that little or no damage could occur as a result of an earthquake. This area is fairly free of earthquakes (DOE 1996a:3-165). Between 1906 and 1986, as few as 36 earthquakes were felt by persons in the Texas Panhandle. The strongest reported had a Modified Mercalli Intensity of VI. An earthquake of intensity VI is felt by everyone but causes little damage to competent structures. Many of the earthquake epicenters are associated with the Amarillo Uplift, about 32 km (20 mi) north of Pantex. An earthquake with a maximum horizontal acceleration of 0.17g is calculated to have an annual probability of occurrence of 1 in 5,000 at Pantex (Barghusen and Feit 1995:2.10–14).

There are no volcanic hazards at Pantex because there are no known areas of active volcanism in the Texas Panhandle (DOE 1996a:3-165). The nearest volcanic activity occurred 4,000 to 10,000 years ago in northeast New Mexico (M&H 1996a:3-8).

Pantex is underlain by soils of the Pullman-Randall association, which consists of nearly level to gently sloping, deep noncalcareous clays (i.e., clays containing no calcium carbonate [calcite]) and clay loams. Pullman soils underlie most of the Pantex area, but Randall soils occur in the vicinity of the playas and depressions (DOE 1996a:3-165). The Pullman soil is classified as prime farmland soil (M&H 1997:17). Soils at Pantex are acceptable for standard construction techniques (DOE 1996a:3-165). More detailed descriptions of the geology and the soil conditions at Pantex are included in the *Storage and Disposition PEIS* (DOE 1996a:3-165, 3-166) and the *Environmental Information Document for the Pantex Plant EIS* (M&H 1996a:3-1–3-53).

3.4.6.2 Proposed Facility Location

The soil types near Zone 4 West are Pullman clay loam (0 to 1 percent and 1 to 3 percent slopes) and Osteocyte clay loam (1 to 3 percent slopes). Neither of these soils is subject to liquefaction or is unstable (M&H 1997:17).

3.4.7 Water Resources

3.4.7.1 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.

3.4.7.1.1 General Site Description

Pantex is situated on a flat portion of the Southern High Plains of Texas. No streams or rivers flow through Pantex. Major surface water in the vicinity includes the Canadian River, 27 km (17 mi) north of the plant, Sweetwater Creek and the Salt Fork of the Red River, respectively 80 km (50 mi) and 32 km (20 mi) to the east, and the Prairie Dog Fork of the Red River, 56 km (35 mi) to the south. The Canadian River flows into Lake Meredith about 40 km (25 mi) north of the plant. Water from Lake Meredith is mixed with water pumped from the Ogallala aquifer for use as drinking water for several Southern High Plains cities. No hydrologic connections exist to transport contaminants from Pantex into either the Canadian River or Lake Meredith (M&H 1996a:5-4, 5-5).

The only naturally occurring bodies of water on the plant site are the playas and very small, unnamed, intermittent channels and ditches that may feed storm water into them. There are three playas (Playas 1, 2, and 3) on Pantex property, two (Playas 4 and 5) on the Texas Tech University property, several adjacent to Pantex, and one, called Pantex Lake, on DOE-owned property about 4 km (2.5 mi) northeast of the main portion of Pantex. Pantex Lake received discharges from the old sewage treatment facility from 1942 until the early 1970s; however, flows from the wastewater treatment facility are now discharged to Playa 1 as permitted by the State of Texas and the EPA. Currently, there are no industrial discharges diverted to Pantex Lake, Playa 3, or Playa 5, although all of the playas receive surface water runoff from precipitation events (Barghusen and Feit 1995:2.10-17–2.10-20).

Studies have suggested that most of the recharge of the underlying Ogallala aquifer within the Southern High Plains originates from water stored in the playas. However, the playas are frequently dry because of the high, naturally occurring evaporation rate combined with a rate of infiltration that normally exceeds the rate of inflow. Playas in the area of the plant may be as large as 1,220 m (4,000 ft) in diameter and more than 9 m (30 ft) deep. Most of the playas are floored with a clay accumulation at the bottom that is lens shaped, being thickest in the middle and thinning out toward the edges. These clay floors may contain desiccation cracks up to 1.8 m (6 ft) deep when the floor is dry (Barghusen and Feit 1995:2.10-17).

The only surface waterway that flows throughout the year is the one that receives flow from the Wastewater Treatment Facility and discharges into Playa 1. In 1996, discharge to the waterway was 1,242,400 l/day (328,200 gal/day). The Wastewater Treatment Facility receives and treats sanitary waste flows and some process wastewater flows. Effluent from the Wastewater Treatment Facility is monitored pursuant to the plant's NPDES permit and TNRCC permits. The remaining channels and ditches contain flows only after storm events (DOE 1997c:112).

Industrial and storm-water discharges are authorized by State and Federal permits. Pantex is authorized to discharge wastewater into Playas 1, 2, and 4 under NPDES Permit TX0107107, issued June 1, 1996, and TNRCC Wastewater Discharge Permit 02296, issued June 14, 1996. These permits define the volume and quality

of effluent flows that may be discharged to the playas. Storm water from industrial activities is permitted to be discharged into Playas 1, 2, 3, and 4 by general NPDES Permit TXR00G138, issued February 15, 1995. Pollution prevention plans are required by this permit, which establishes 10 outfalls throughout Pantex where effluent samples are to be taken (M&H 1997:15). Pantex is currently transitioning to the new Multi-Sector General Permit for Storm Water. This permit will require monitoring at 8 storm water outfalls (Weinreich 1997). Pantex is also authorized to discharge storm water from construction activities that disturb more than 2 ha (5 acres) under the "Final NPDES General Permits for Storm Water Discharges from Construction Sites" (57 Federal Register 41176). A notice of intent is filed for each individual construction project and a pollution prevention plan is prepared and implemented. No sampling requirements are associated with these permitted activities (M&H 1997:15). On September 14, 1998 (63 Federal Register 51164), the State of Texas was authorized by EPA to assume administration of the NPDES permit program. While permits already issued by EPA will remain in effect until they expire or are replaced by a TNRCC-issued permit, this will ultimately result in consolidation of the industrial and storm-water discharge permits held by Pantex under the Texas Pollutant Discharge Elimination System (EPA 1998a).

The playas are considered by the State of Texas to be "waters of the State." The Pantex playas have been designated as jurisdictional wetlands, and therefore are also waters of the United States (DOE 1996a:3-157). Including monitoring required by NPDES and TNRCC permits, surface water is monitored for radioactive and nonradioactive parameters at 37 onsite locations, including the playas (DOE 1997c:iii).

Sampling data for surface waters at the site in 1996 showed that concentrations of radionuclides were similar to historical levels and lower than the derived concentration guides for ingested water (DOE 1997c:table 10.2). Moreover, little concern emerged during the monitoring of surface waters, and discharges to them, for a variety of other parameters, including organics, metals, explosives, polychlorinated biphenyls, and pesticides. Toluene was detected twice at the wastewater treatment plant effluent outfall (Outfall 001); however, it was not detected in the plant influent 30 days prior to sampling. No noncompliances were reported at any of the other monitored outfalls or sampling points on the site. Throughout the 1996 sampling season, Pantex Lake was dry, and no samples could be collected (DOE 1997c:116).

On December 2, 1997, EPA issued Mason & Hanger Corporation at Pantex an Administrative Order regarding its NPDES Permit No. TX107107. During 1997, Pantex periodically exceeded some discharge limits set by the permit. The exceedances included ammonia, oil and grease, total suspended solids, and total metals. Although Pantex exceeded the limits set by the EPA permit, based on all available data, the levels of constituents found in the wastewater do not pose a threat to public health or the environment. The Administrative Order required correction of exceedances within 30 days, and for those exceedances that could not be corrected within 30 days, submittal of a corrective action plan. A comprehensive plan was submitted to EPA on December 22, 1997. EPA indicated that it intended to use the plan to develop a negotiated compliance agreement. The complaince agreement was signed on November 24, 1998 by DOE (Battley 1999). Pantex is proceeding with implementation of its corrective action plan. Corrective actions include upgrading the Wastewater Treatment Facility; soil stabilization and erosion control measures; and operational, maintenance, and monitoring program modifications. These engineered solutions are scheduled for completion in the year 2003 (Nava 1998; DOE 1999a).

An EA was recently completed for the wastewater treatment plant upgrade (DOE 1999d) and a FONSI was issued (DOE 1999e). As selected in the FONSI, the project to upgrade the existing Wastewater Treatment Facility will essentially involved the construction of a new, zero-discharge facility south of the current facility and outside the 100-year floodplain of Playa 1. Specifically, two new lagoons will be constructed, one serving as a facultative treatment lagoon and the second as an irrigation water storage reservoir and alternate treatment lagoon. The existing Wastewater Treatment Facility lagoon will be retained as a supplemental storage facility for treated wastewater effluent.

Beginning in 2003, instead of being discharged to Playa 1, treated effluents will be disposed of via land application for the irrigation of crops in cooperation with the Texas Tech University Research Farm. Either a subsurface flow system, a center-pivot system, or an overland flow irrigation system will be used to apply effluents (DOE 1999d, 1999e).

Water rights in Texas fall under the Doctrine of Prior Appropriations. Under this doctrine, the user who first appropriates water for a beneficial use has priority in the use of available water supplies over a user claiming rights at a later time. Courts also recognize riparian rights legally granted in Spanish-American Agreements. TNRCC is the administrator for water rights and the permit-issuing authority (DOE 1996a:3-160). Because Pantex does not use any surface water, it exerts no surface water rights.

Figure 3–23 shows the surface water drainage basins for each of the playas (DOE 1996f:4-76). Storm-water runoff from the industrialized areas of Pantex collects within the playas and the tailwater pit and does not flow offsite. Storm water that is collected in the tailwater pit at the northeast boundary of the site is pumped to a ditch that flows to Playa 1 (M&H 1996a:5-7). General flooding of some low-lying portions of Pantex could occur as a result of runoff associated with precipitation and the subsequent filling of the playas. Historically, there has been no major flooding at the Pantex site (M&H 1996a:5-17–5-24; 1996b:2-11). There are no federally designated Wild and Scenic Rivers on the site (Barghusen and Feit 1995:2.10-2).

3.4.7.1.2 Proposed Facility Location

Most surface runoff near Zone 4 West flows to Playa 1(M&H 1996b:2-11; 1997:24). However, a very small portion of this area flows to Playa 2. The distance between the proposed surplus plutonium disposition facilities and the drainage basin divide is sufficient to prevent storm-water flows from the proposed facilities from entering Playa 2. Playa 1 has a surface area of 32 ha (79 acres) and Playa 2, 30 ha (74 acres) (M&H 1996a:5-6). A review of flooding maps of the playas indicates that the 100-year flood elevation for Playa 1 is 1,073.4 m (3,522 ft) and for Playa 2 it is 1,074.7 m (3,526 ft). The elevation of the proposed facilities is 1,084 m (3,556 ft) (DOE 1996f:4-77).

Playa 3 is upgradient from the proposed surplus plutonium disposition facilities and the 100-year flood elevation is 1,086.5 m (3,565 ft). The maps indicate that water elevations above that of the 100-year flood would result in sheet overflow at shallow depths in the direction of the proposed facilities. Figure 3–23 shows the approximate extent of the floodplains at Pantex (DOE 1996b:4-76).

Results of surface water quality sampling from 1994 confirm that Pantex was in compliance with all water quality regulations for Playa 1 and that, with the exception of a high water level in Playa 1 in July 1994 attributable to a rainfall event, all permit requirements were met (DOE 1996a:3-157).

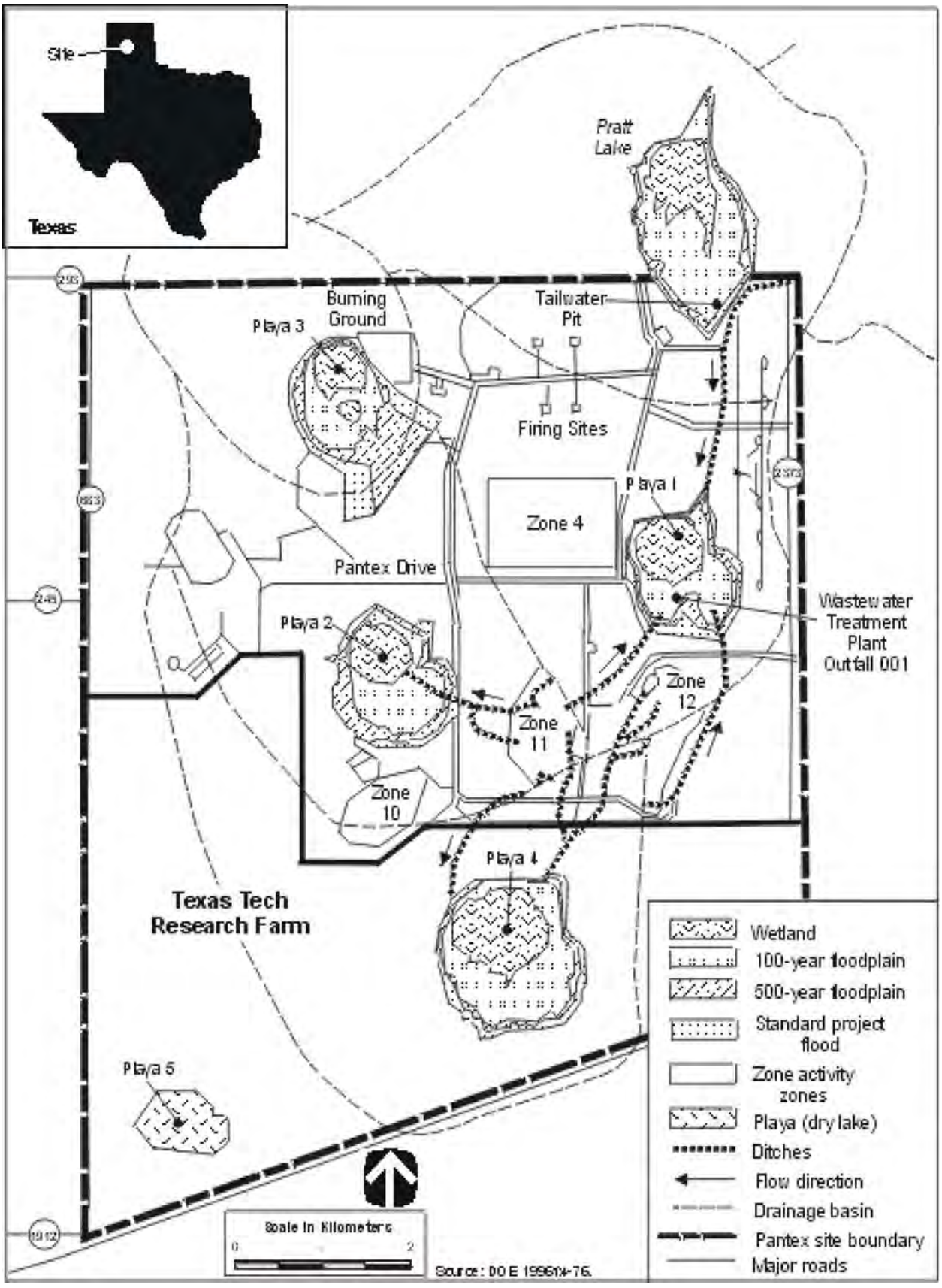


Figure 3–23. Locations of Floodplains and Playas at Pantex

3.4.7.2 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.

3.4.7.2.1 General Site Description

The three primary hydrostratigraphic units, (i.e., separate layers of water), in the vicinity of Pantex are the Blackwater Draw Formation, the Ogallala Formation, and the Triassic Dockum Group. The units as a whole constitute the vadose (unsaturated) zone, the saturated perched aquifer zone, and the lower, saturated main aquifer below the site (M&H 1996a:4-1).

The Blackwater Draw Formation has been identified as the most widespread post-Ogallala unit throughout the Southern High Plains. It consists of modified eolian sands and silts interbedded with numerous caliches composed of variably cemented carbonate layers and nodules. The thickness of the Blackwater Draw Formation at Pantex is variable, ranging from 15 to 24 m (50 to 80 ft) (M&H 1996a:4-4).

The High Plains aquifer, commonly referred to as the Ogallala aquifer, underlies the southern part of the Great Plains physiographic province. It is the primary water source for the Texas Panhandle and eastern New Mexico. The Ogallala aquifer in the vicinity of Pantex consists primarily of the saturated lower Ogallala Formation, although water is also produced from strata as old as Permian (M&H 1996a:4-4).

The Ogallala aquifer exists in unconfined conditions. Recharge occurs from precipitation and subsequent infiltration of surface water either through surface soils or through focused recharge from the numerous playas that occur across the area. Direct recharge of the aquifer can occur in those limited areas where the aquifer formation is at the surface, but no outcrops exist at Pantex. Recent evidence supports significant recharge of the aquifer below the playas in the Southern High Plains; however, evidence of such recharge has not been determined for the Ogallala aquifer at Pantex (M&H 1996a:4-1).

Depths to the Ogallala aquifer generally run parallel to the regional land surface, which dips gently from northwest to southeast (M&H 1996a:3-36, 4-15). The depth to the Ogallala aquifer at Pantex varies from about 104 m (341 ft) at the southern boundary to 140 m (459 ft) at the northern boundary (M&H 1997:14). This south-to-north groundwater flow contrasts with the regional northwest-to-southeast trend of the remaining portion of the Southern High Plains. Localized disruption of these generalized flow patterns can occur where significant withdrawals are made, such as near the city of Amarillo Carson County well field about 3.2 km (2 mi) northeast of Pantex (M&H 1996a:4-1).

The Triassic Dockum Group underlying the Ogallala Formation is believed to be as thick as 30 m (100 ft) under Pantex. The lateral extent, thickness, and hydraulic characteristics of this group have not been established beneath Pantex, and well logs usually identify these only as Triassic or red beds (M&H 1996a:4-4, 4-5). However, limited data from regional hydrogeologic studies of the Dockum Group divide it into an upper and a lower section, with only the Lower Dockum Group inferred to exist beneath portions of Carson County, including the southwest portion where Pantex is located. The Lower Dockum Group consists predominantly of fine to coarse-grained sandstones and granular and pebble conglomerate along with mudstone sequences of alluvial, deltaic, and lacustrine origin. It has a thickness of less than 61 m (200 ft) beneath southwestern Carson County, consistent with site-specific data (Dutton and Simpkins 1986:3-4).

The water-bearing stratum of the Lower Dockum Group is the Lower Dockum aquifer. Regionally, the surface of the aquifer lies 91 to 213 m (300 to 700 ft) below the water table of the Ogallala aquifer and below the base of the Ogallala Formation (Dutton and Simpkins 1986:13). Any interconnection between the High Plains (Ogallala) aquifer system and the Lower Dockum aquifer across most of the Southern High Plains is thought to be poor at best, with little current recharge occurring (having ended during the Pleistocene epoch) (Dutton and Simpkins 1986:13, 24). Although at Pantex the upper confining layer of the Lower Dockum aquifer is absent, there are indications that it may be hydraulically connected to the overlying Ogallala aquifer. (M&H 1996a:4-7, 4-15-16).

The two main water-bearing units beneath the plant are the Tertiary Ogallala Formation and the Triassic Dockum Group. Two water-bearing zones in the Ogallala Formation are present beneath the plant. The first is a perched water zone above the main zone of saturation. One of these is present beneath Playa 1. The perched water zones consist of discontinuous perched water lenses, the lateral extent of which has not been fully determined. The second and deeper water-bearing zone is the Ogallala aquifer, which is the primary source of water for drinking, irrigation, and commercial uses (M&H 1996a:4-5). In general, factors such as well yield, depth to water, and high solids content limit production of the Lower Dockum Group aquifer for potable purposes. Irrigation water is supplied by the Dockum Group rather than the Ogallala Formation in locations to the west and south of Pantex, but Ogallala water is reportedly mixed with groundwater from the Dockum Group to meet the potable water needs of a few municipalities (Dutton and Simpkins 1986:3, 21, 22). There are no designated sole source aquifers near Pantex (Barghusen and Feit 1995:2.10-2).

Five production wells in the northeast corner of Pantex provide water for the plant's needs (DOE 1996a:3-162). Pantex water use has decreased during the period from 1991 to 1995 by 231 million l (61 million gal), from a maximum of 848 million l (224 million gal) of water in 1991, to 617 million l (163 million gal) of water in 1995 (M&H 1996a:4-33, 9-8). In 1995, the city of Amarillo produced 23.6 billion l (6.2 billion gal) of water from the Ogallala aquifer via the Carson County well fields. In addition, approximately 101 billion l (27 billion gal) of water were applied for irrigation in Carson County in 1995 (DOE 1996f:4-104).

Groundwater is controlled by the individual landowner in Texas through the Doctrine of Prior Appropriations (DOE 1996a:3-160). 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. Pantex is in Panhandle Groundwater District 3, which has the authority to require permits and limit the quantity of water pumped. Historically, the Panhandle Groundwater Conservation District has not limited the quantity of water pumped. However, for wells drilled after July 19, 1995, that produce more than 1,300,000 1/yr (350,000 gal/yr) per acre owned, landowners will be required to obtain a High Production Permit from the Panhandle Groundwater Conservation District (DOE 1996f:4-105).

As described in Section 3.4.10.1, the DOE-owned portion of Pantex is approximately 41 km^2 (4,100 ha or 10,100 acres) in area. Therefore, a High Production Permit would be required if DOE were to exceed approximately 13 billion 1/yr (3.4 billion gal/yr) of groundwater withdrawals. As shown in Table 3–36, the current usage is about 850 million 1/yr (225 million gal/yr), with a system capacity of about 3.8 billion 1/yr (1 billion gal/yr). Further detail on the groundwater resources at Pantex may be found in the *Storage and Disposition PEIS* (DOE 1996a) and the *Environmental Information Document: The Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components EIS* (M&H 1996a).

3.4.7.2.2 Proposed Facility Location

Given the nature and extent of the Ogallala aquifer, the general site description is believed to be representative of conditions beneath Zone 4 West. Water for the proposed facilities would be supplied from the existing site water system, which uses groundwater; no surface water would be used (M&H 1997:13).

3.4.8 Ecological Resources

Ecological resources are defined as terrestrial (predominantly land) and aquatic (predominantly water) ecosystems characterized by the presence of native and naturalized plants and animals. For the purposes of this SPD EIS, those ecosystems are differentiated in terms of habitat support of threatened, endangered, and other special-status species—that is, "sensitive" versus "nonsensitive" habitat.

3.4.8.1 Nonsensitive Habitat

Nonsensitive habitat comprises those terrestrial and aquatic areas of the site that typically support the region's major plant and animal species.

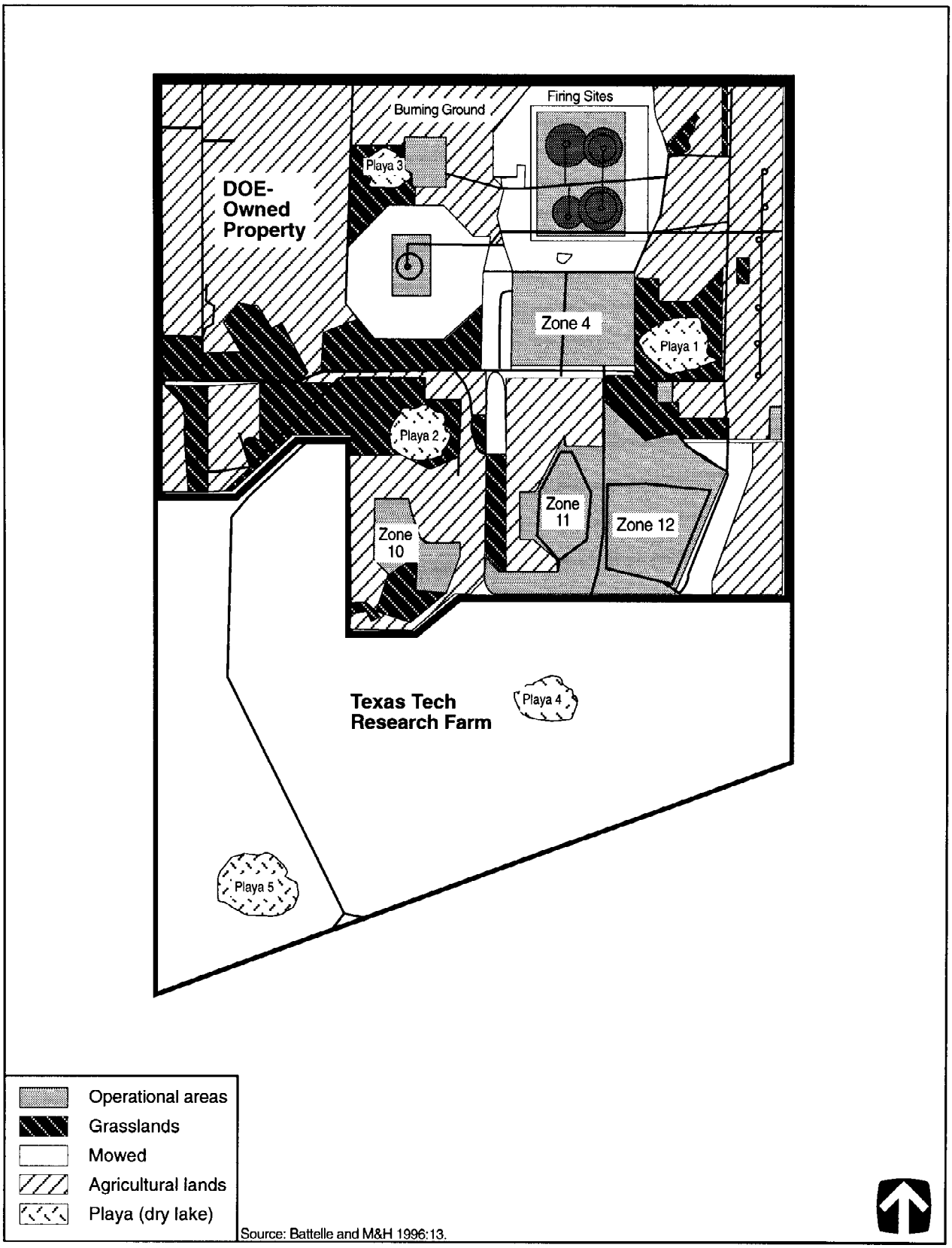
3.4.8.1.1 General Site Description

Pantex is on a treeless portion of the High Plains where 229 plant species and numerous animal species thrive (DOE 1996a:3-166). Short-grass prairie grasslands were the native vegetation until the prairie was converted to agricultural use for crops, grazing, or protective vegetative cover under the Conservation Reserve Program. The few remaining native grassland areas are heavily grazed by livestock. Such grazing has transformed much of the rangeland from the native blue grama-buffalo grass to brush, forbs, or cacti. Essentially all land at Pantex has been managed or disturbed to some degree. The following five basic habitat types have been identified: operational areas, grasslands, mowed areas, agricultural croplands, and playas as shown in Figure 3–24 (Battelle and M&H 1996:8, 11).

Animal species found at Pantex include 7 species of amphibians, 43 species of birds, 19 species of mammals, and 8 species of reptiles. Common bird species known to exist in the vicinity of Pantex include the western meadowlark, mourning dove, horned lark, and several species of sparrows. Raptors on the site include the Swainson's hawk, American kestrel, and burrowing owl. Frequently sighted mammals include the black-tailed jackrabbit, black-tailed prairie dog, and hispid cotton rat. Although hunting is not permitted on the site, game animals include the desert cottontail, northern bobwhite, scaled quail, and numerous waterfowl. Predators present include the badger and coyote (DOE 1996a:3-166).

Aquatic habitats are limited to Playa 1, several wastewater treatment lagoons, and ditches, and five playas that contain water after precipitation events (Playas 2, 3, 4, and 5, and Pantex Lake). Vegetation in these areas is quite variable. Playa 1 receives treated effluent from the wastewater treatment facility, and because of this year round flow supports extensive stands of barewaist cattail, tule, or soft-stemmed bulrush. Playa 2 is nearly covered with smartweeds, while longspike spikerush is the most abundant species at Playa 3. Pantex Lake, the largest playa, supports a large number of species, longspike spikerush and wooly bursage being the most common, as is the case for Playa 4. Playa 5 is on Texas Tech University property and is not influenced by Pantex activities. The diversity of macroinvertebrates is playa-specific, and more than 80 species have been recorded (Battelle and M&H 1996:20–22).

Birds are the most conspicuous animal associated with the playas in terms of numbers, diversity, and biomass. Situated along the central flyway migratory route, the playas provide valuable habitat for migration, wintering, and nesting. The most common wintering ducks are mallards, northern pintails, green-winged teals, and



Source: Battelle and M&H 1996:13.

Figure 3–24. Generalized Habitat Types at Pantex (Main Plant Area)

American wigeons. Species known to breed in playas include the mallard, northern pintail, blue-winged teal, cinnamon teal, northern bobwhite, western meadowlark, yellow-headed blackbird, red-winged blackbird, and ring-necked pheasant (Battelle and M&H 1996:22).

3.4.8.1.2 Proposed Facility Location

The immediate environs of Zone 4 West are mowed for security and fire protection purposes. The security fencing system around Zone 4 West contains bare ground, whereas the interior of the zone contains areas of buffalo grass between structures (M&H 1997:20). An agricultural area northwest of Zone 4 West is regularly planted with winter wheat. South of the zone is a previously cultivated area that has been revegetated with native grass species of buffalo grass, blue grama, and sideoats grama (King 1997a:8). Several animal species could be present in and around Zone 4 West. Mammals sighted in this area include the cottontail rabbit, black-tailed jackrabbit, striped skunk, coyote, and thirteen-lined ground squirrel. Reptiles and amphibians known to inhabit the area include the prairie rattlesnake, Texas horned lizard, Great Plains skink, bull snake, Great Plains toad, plains spadefoot toad, and tiger salamander. Birds found in the area include the western burrowing owl, western meadowlark, western kingbird, eastern kingbird, American kestrel, horned lark, mourning dove, pigeon, grasshopper sparrow, and numerous waterfowl and other species associated with wetlands (King 1997a:8; M&H 1997:20).

3.4.8.2 Sensitive Habitat

Sensitive habitat comprises those terrestrial and aquatic (including designated wetlands) areas of the site that support threatened and endangered, State-protected, and other special-status plant and animal species.[7]

3.4.8.2.1 General Site Description

Playas 1, 2, 3, and 4 and Pantex Lake have been designated by USACE as jurisdictional wetlands and are therefore regulated pursuant to Section 404 of the Clean Water Act (Battelle and M&H 1996:20).

Ten threatened, endangered, or other special-status species listed by the Federal Government or the State of Texas may be found in the vicinity of Pantex, as shown in Table 3.5.6–1 in the *Storage and Disposition PEIS* (DOE 1996a:3-166).

3.4.8.2.2 Proposed Facility Location

Portions of the drainage basins for Playas 1, 2, and 3 lie in or near Zone 4 (see Figure 3-23). Some shorebirds and waterfowl (e.g., grebes, blackbirds, teals, ducks, and heron) nest or feed within the grasslands and cultivated fields associated with these playas (King 1997a; M&H 1997:21).

Although there is no critical habitat for any threatened or endangered species at Pantex, four special-status species may be found within the environs of Zone 4 West, as shown in Table 3–35. The ferruginous hawk is a common winter resident that feeds on prairie dogs and cottontail rabbits. The area west of Zone 4 West is a potential feeding location because of its prairie dog towns. The prairie dogs are removed from this area at least annually. Also associated with the prairie dog towns is the western burrowing owl. Up to 10 pairs have been identified as nesting in the area just west of Zone 4 West. Although not observed anywhere on Pantex since 1996, the swift fox (*Vulpes velox*), a candidate for Federal listing as a threatened or endangered species, may be present

[7] The Federal Government defines threatened and endangered species in the Endangered Species Act, and wetlands in 33 CFR 328.3.

on the site, judging from the historical observation of field indicators in areas adjacent to Zone 4 and Zone 4 West. The Texas horned lizard is fairly common and is seen most frequently around the

Table 3–35. Threatened and Endangered Species, Species of Concern, and Sensitive Species Occurring or Potentially Occurring in Areas Surrounding Zone 4 West

Common Name	Scientific Name	Federal Status	State Status
Birds			
Ferruginous hawk	*Buteo regalis*	Species of Concern	Not listed
Western burrowing owl	*Athene cunicularia hypugea*	Species of Concern	Not listed
Mammals			
Swift fox	*Vulpes velox*	Candidate species	Not listed
Reptiles			
Texas horned lizard	*Phrynosoma cornutum*	Species of Concern	Threatened

Source: M&H 1997:21, 22.

playas. Because it feeds mainly on harvester ants found throughout Pantex, there is a high probability of its occurrence in and around Zone 4 West (M&H 1997:21, 22).

3.4.9 Cultural and Paleontological Resources

Cultural resources are human imprints on the landscape and are defined and protected by a series of Federal laws, regulations, and guidelines. Pantex has a well-documented record of cultural resources. These resources include 69 archaeological sites indicating prehistoric Native American and historic European-American occupation and use. They also include the standing structures, foundations, and other extant features once part of the Pantex Ordnance Plant (1942-1945), the World War II predecessor of Pantex. In addition, many structures and features associated with Cold War era (1951-1991) operations at the plant are included in the cultural resource inventory. Pantex also maintains valuable historic documents, records, and artifacts pertinent to interpretation of the prehistoric and historic human activities conducted on the site (M&H 1996a).

Cultural sites are often occupied continuously or intermittently over substantial time spans. For this reason, a single location (sites) may contain evidence of use during both historic and prehistoric periods. In the discussions that follow, the numbers of prehistoric and historic resources are presented; the sum of these resources may be greater than the total number of sites reported due to this dual-use history at sites. Therefore, where the total number of sites reported is less than the sum of prehistoric and historic sites certain locations were used during both periods.

Approximately 50 percent of Pantex, including DOE-leased and -owned property, has been surveyed for archaeological resources. Both the Texas State Historic Preservation Officer and the Advisory Council on Historic Preservation have agreed that additional archaeological surveys are not required. All World War II buildings, structures, and remains at Pantex have been surveyed and recorded. A building survey and an oral history program on the Cold War period are ongoing. By calendar year 1999, all the plant's cultural resources will be managed under a comprehensive Cultural Resource Management Plan required by the National Historic Preservation Act. Until that time, resources will be effectively managed through existing case-by-case procedures and interim agreements that comply with the act (M&H 1997:26, 27).

3.4.9.1 Prehistoric Resources

Prehistoric resources are physical properties that remain from human activities that predate written records.

3.4.9.1.1 General Site Description

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 about one-half of the facility. About 60 prehistoric sites have been recorded to date on DOE and Texas Tech University property. In consultation with the Texas State Historic Preservation Officer and the Advisory Council on Historic Preservation, DOE has determined that only two prehistoric archaeological sites are potentially eligible for inclusion on the National Register.

3.4.9.1.2 Proposed Facility Location

There are no National Register–eligible sites near Zone 4 West (M&H 1997:26, 27).

3.4.9.2 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.

3.4.9.2.1 General Site Description

Historic resources at Pantex include European-American farmstead sites represented by foundations and artifact scatters; World War II era buildings, structures, and foundations; and Cold War era buildings and structures. To date, 12 European-American farmstead sites have been surveyed and recorded. In consultation with the Texas State Historic Preservation Officer and the Advisory Council on Historic Preservation, DOE has determined that these sites are not eligible for inclusion on the National Register. All remaining World War II era buildings, structures, and foundations have been surveyed and recorded. Under the terms of the programmatic agreement executed in October 1996 among DOE, the Texas State Historic Preservation Officer, and the Advisory Council on Historic Preservation (DOE 1996g), plant properties requiring modification are reviewed by plant staff, and appropriate mitigation is completed.

3.4.9.2.2 Proposed Facility Location

According to existing information, it is unlikely that unrecorded historic sites exist within Zone 4 West. If required, additional reviews by the State Historic Preservation Office are expected to be minimal (M&H 1997:27). Inadvertent discoveries will be addressed as discussed in Chapter 5.

3.4.9.3 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. The identification of these resources is determined through consultations with potentially affected Native American groups (see Chapter 5 and Appendix O).

3.4.9.3.1 General Site Description

A treaties search has been completed, indicating that four federally recognized Native American tribes, the Kiowa, Comanche, Apache, and Cheyenne-Arapaho Tribes of Oklahoma, are culturally affiliated with the Texas Panhandle region. Pantex staff have contacted these four and six additional tribes: the Mescalero and Jicarilla Apache Tribes, the Caddo Tribe of Oklahoma, the Delaware Tribe of Western Oklahoma, the Wichita and

affiliated tribes, and the Fort Sill Apache Tribe. As a result of these consultations no mortuary remains, associated artifacts, or traditional cultural properties have been identified at Pantex, nor are they likely to be (M&H 1997:27).

3.4.9.3.2 Proposed Facility Location

Zone 4 West does not contain any recognized Native American resources. Consultations (see Chapter 5 and Appendix O) were initiated with appropriate Native American groups to determine any concerns associated with the actions evaluated in this SPD EIS.

3.4.9.4 Paleontological Resources

Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geological age.

3.4.9.4.1 General Site Description

The surficial geology of the Pantex area consists of silts, clays, and sands of the Blackwater Draw Formation. In other areas of the Southern High Plains, this formation contains Late Pleistocene vertebrate remains including bison, camel, horse, mammoth, and mastodon, with occasional evidence of their use by humans (M&H 1997:27).

3.4.9.4.2 Proposed Facility Location

No paleontological resources have been reported for Zone 4 West.

3.4.10 Land Use and Visual Resources

3.4.10.1 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, cultural, geological, aquatic, and atmospheric).

Pantex is in Carson County, approximately 27 km (17 mi) northeast of downtown Amarillo. The operational activities of the site are confined to 60 km^2 (23 mi^2) of land, of which approximately 37 km^2 (14 mi^2) are owned by the Federal Government. The remaining lands are leased from Texas Tech University to provide a safety and security buffer zone. In addition to the Pantex site, DOE owns a 4.4 km^2 (1.7 mi^2) portion of a large playa approximately 6.4 km (4 mi) northeast of the plant (DOE 1996a:3-148).

3.4.10.1.1 General Site Description

Regional land use within an 80-km (50-mi) radius of Pantex is predominately agricultural (DOE 1996f:4-26). Most of this expanse is devoted to rangeland along the Canadian River drainage north of Pantex and in the tributary drainage of the Red River to the south (DOE 1996f:4-26). Cropland, for both irrigated and dry-land crops, is the second largest land-use category behind rangeland. Some private property owners have enrolled their land in the Federal Conservation Reserve Program. Under terms of the program, the land cannot be cultivated or grazed for 10 years (DOE 1996f:4-22). However, most of the land is cultivated. The land surrounding Pantex is rural private property. The closest offsite residences are approximately 48 m (160 ft) from the plant boundary in the western and northeastern sectors (DOE 1996a:3-148).

Commercial, residential, industrial, institutional, and public lands constitute a small part of the total land use within an 80-km (50-mi) radius. These areas are associated mainly with the towns and cities of the region (DOE 1996f:4-26). Amarillo, which is primarily residential, is the largest urban area in the region.

Land-use categories at Pantex include industrial, agricultural, rangeland, open space, and playa areas. Generalized land uses at Pantex and the vicinity are shown in Figure 3–25. Several areas of land not actively committed to Pantex operations are used by Texas Tech University for agricultural purposes. Agricultural activities generally consist of dry farming and livestock grazing. The soil at Pantex contains several types that, according to the Natural Resources Conservation Service have been classified as prime farmland soils (DOE 1996a:3-148).

Approximately 23 percent of the Pantex site has been developed for industrial use (DOE 1996f:4-21). Pantex is divided into four major working areas: manufacturing, high-explosives development, test firing sites, and support facilities. The manufacturing area is devoted to the fabrication of high-explosives components and weapons assembly and disassembly operations. The area in which nuclear weapons operations are conducted covers approximately 80 ha (200 acres) and contains more than 100 buildings (DOE 1983:3-1). This area is surrounded by a security zone.

DOE will manage future land and facility use at Pantex through the land- and facility-use planning process. Guidance for future site development and reuse is based on long-term goals and objectives shared by DOE and stakeholders (DOE 1996f:4-24). Pantex has a *Site Development Plan* that depicts the plant upon completion of the projects outlined in the *Technical Site Information Five Year Plan*. Land resources at Pantex are expected to remain constant with continued leasing of Texas Tech University land for security and safety reasons (M&H 1996a:10-31). *The Integrated Plan for Playa Management at Pantex Plant* provides land-use guidelines for the playas and surrounding areas. This plan is being implemented as a best management plan to protect cultural and natural resources (M&H 1996c:10-41).

Within the State of Texas, land-use planning occurs only at the municipal level. The *1995 City of Amarillo Comprehensive Plan* has designated land for future growth within the city limits (DOE 1996f:4-33). Future residential development is expected to the southwest, away from the Pantex site. 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 land use in the area, the comprehensive plan encourages compatible rather than residential use (DOE 1996a:3-148). No future land use has been projected by the city of Amarillo or county planning agencies (M&H 1996a:10-31).

No onsite areas are subject to Native American Treaty Rights.

3.4.10.1.2 Proposed Facility Location

| Existing land use within Zone 4 West is designated as industrial. It contains the weapons/high-explosives magazines and interim pit storage area (DOE 1996f:4-21). It also supports various DOE nuclear weapons design agencies. The land is currently disturbed and is designated for high-explosives development. Zone 4 is 1.8 km (1.1 mi) from the nearest site boundary.

Areas immediately adjacent to the zone to the north, south, and west are designated as open space. Lands to the east are primarily designated as rangeland and agricultural land. About 0.4 km (0.2 mi) to the east of Zone 4 is the Playa 1 Management Unit. Playa 1 currently receives permitted industrial and sanitary sewage effluents from the wastewater treatment facility as well as storm-water runoff from Zones 4, 11, and 12 (M&H 1996c:4). According to the *Facility Assessment Visual Site Inspection Report* prepared under RCRA (M&H 1996c:4), previous discharges of industrial pollutants into the playa have resulted in its classification as a solid

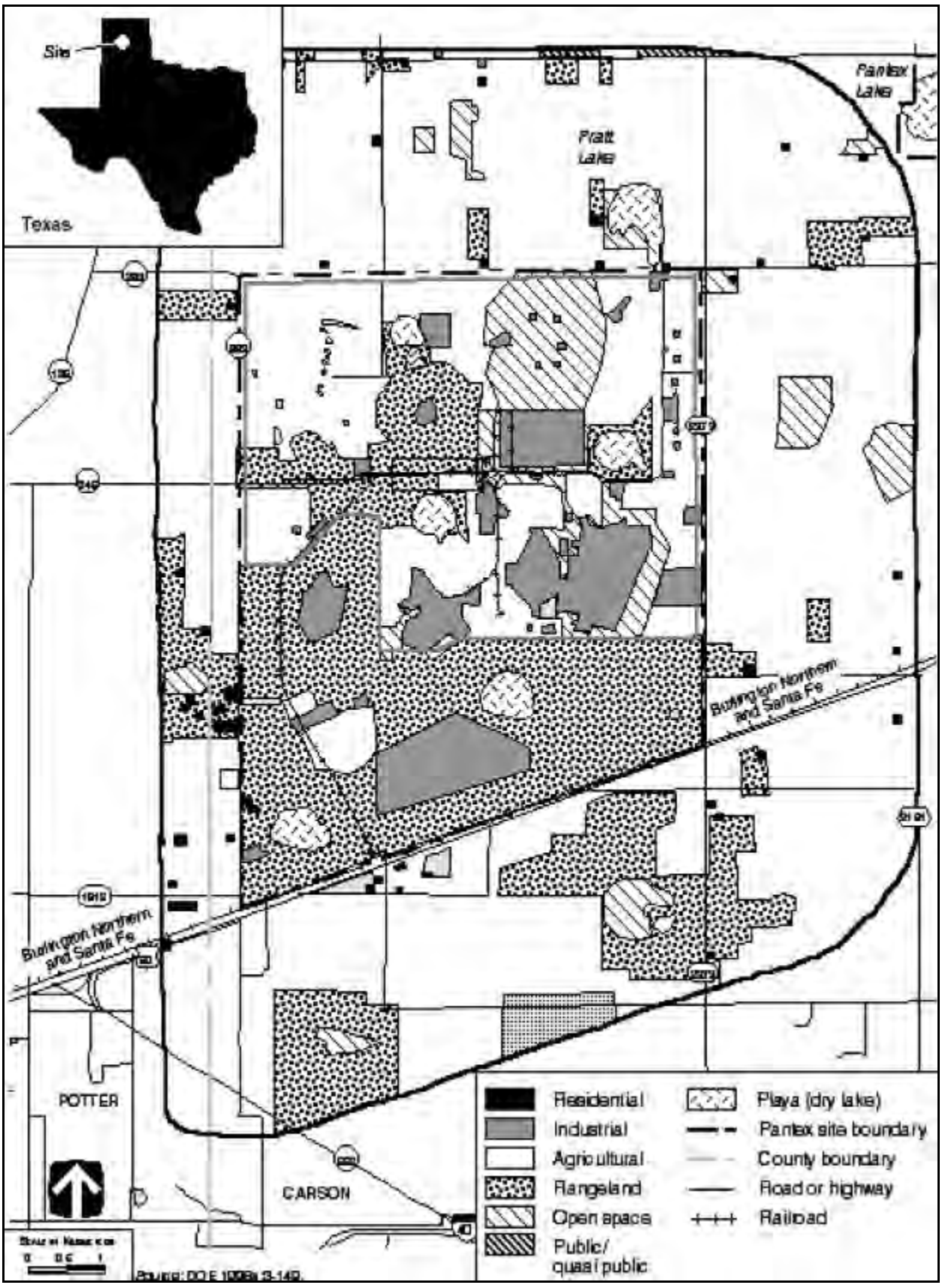


Figure 3–25. Generalized Land Use at Pantex and Vicinity

waste management unit (SWMU). Any activities disturbing the soils within an SWMU, including remedial activities, are regulated under RCRA and require additional management (M&H 1996c:4).

3.4.10.2 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.

3.4.10.2.1 General Site Description

Pantex is in the treeless Southern High Plains of Texas. It lies in the transition zone between the North Central Plains and the Llano Estacado (staked plains) to the south. The landscape typically consists of cultivated cropland and rangeland. The plant consists of operational facilities and the inactive facilities of the former World War II ammunition plant. These industrial uses are surrounded by cropland and rangeland that blend into the offsite viewscape. The developed areas of Pantex are consistent with a VRM Class IV designation. The remainder of Pantex is consistent with VRM Class III or IV (DOE 1996a:3-148; DOI 1986a, 1986b).

Public access to the plant is strictly controlled. Access to the plant perimeter is limited to three Texas FM roads and U.S. Route 60. The most visible and sensitive vantage point for Pantex facilities is located 2.4 km (1.5 mi) southeast at the intersection of U.S. Route 60 and FM 2373. U.S. Route 60 is part of the Texas Plains Trail, a scenic road on which Pantex is a designated point of interest. From this road, parts of the plant are visible as low clusters of buildings on a flat landscape. The most visible structures include a new water tower in Zone 11, with a height of 45 m (148 ft), and the twin stacks of the steam plant, each with a height of 20 m (65 ft). The tallest structure at Pantex is a 60-m (197-ft) meteorological tower in the northeast corner of the site (Greenly 1999). This tower would normally be visible as a pencil-thin line from a distance of 1.6 km (1 mi) or less. The operations areas are well defined at night by the security lights. Plant facilities are also visible from I–40, a motorist rest area approximately 10 km (6.2 mi) away being the closest vantage point. The view from this point is similar to that described for U.S. Route 60, but because of the greater distance, the plant facilities are more obscure (DOE 1996a:3-148).

3.4.10.2.2 Proposed Facility Location

Zone 4 West, which houses existing industrial facilities, is not visible from U.S. Route 60, including the intersection of U.S. Route 60 and FM 2373. The new water tower and the twin stacks of the steam plant are the features most visible from offsite. Operations areas are well defined at night by the security lights. The closest natural feature of visual interest is Palo Duro Canyon State Park, 45 km (28 mi) to the south. Open space immediately to the west of Zone 4 West is consistent with a VRM Class III or IV designation. Zone 4 West is a developed area consistent with VRM Class IV (DOE 1996a:3-148; DOI 1986a, 1986b; Greenly 1999).

3.4.11 Infrastructure

Site infrastructure includes those utilities and other resources required to support construction and continued operation of mission-related facilities identified under the various proposed alternatives.

3.4.11.1 General Site Description

Pantex has the extensive infrastructure necessary to support operations at the plant. The key components of this infrastructure are summarized in Table 3–36.

Table 3–36. Pantex Sitewide Infrastructure Characteristics

Resource	Current Usage	Site Capacity
Transportation		
Roads (km)	76	76
Railroads (km)	27	27
Electricity		
Energy consumption (MWh/yr)	81,850	420,500
Peak load (MW)	13.6	124
Fuel		
Natural gas (m^3/yr)	12,910,000	248,000,000
Oil (l/yr)	59,960	NA[a]
Coal (t/yr)[b]	NA[b]	NA[b]
Water (l/yr)	851,600,000	3,785,000,000

[a] As supplies get low, more can be supplied by truck or rail.

[b] Coal is not used at Pantex.

Key: NA, not applicable.

Source: King 1997a:5.

3.4.11.1.1 Transportation

An onsite road system of about 76 km (47 mi) of paved surface has been developed (DOE 1996a:3-151). Roads within the plant are classified as either "primary," "secondary," or "tertiary." Primary roads are the main distribution arteries for all traffic outside and within the plant. Secondary roads supplement the primary roads and serve as collector roadways. Both the primary and secondary roads are two-lane, paved arteries. Tertiary roads are frequently single lanes, but some have two lanes when the extra width is justified by traffic volume (M&H 1996a:9-17).

Amarillo is a major rail center on the main lines of the Burlington Northern and Santa Fe, which has internodal facilities in Amarillo. Pantex is connected to the Burlington Northern and Santa Fe system via a spur that enters the plant from the southwest. This spur provides access to the entire system as well as to other railroads (M&H 1996a:9-17, 9-19).

3.4.11.1.2 Electricity

Electrical service for the nine-county region surrounding Pantex is supplied by the Southwestern Public Service Company except for Donley County which is serviced by West Texas Utilities (M&H 1996a:9-1). Generation is mainly from coal, oil, and gas (produced by gas turbines), in order of capacity. The rest comes from nuclear, hydroelectric, and other sources. Pantex draws its power from the West Central Power Pool, characteristics of which are summarized in Table 3.5.2–2 of the *Storage and Disposition PEIS* (DOE 1996a:3-151).

The average electrical availability at Pantex is about 420,500 MWh/yr; the average annual usage, about 81,850 MWh/yr. The peak load capacity for the plant is 124 MW; the current peak load usage, about 13.6 MW (King 1997a:5).

3.4.11.1.3 Fuel

Fuels consumed at Pantex include liquid petroleum fuels and natural gas. Natural gas is supplied by Energas (King 1997a:3). Oil is used as a backup for the Building 16-13 steam boiler. Oil capacity is only limited by the number of deliveries of oil by truck. There is a 89,300-l (23,600-gal) fuel oil storage tank on the site. The current annual site availability of natural gas is about 248 million m^3/yr (8.8 billion ft^3/yr); and the current usage, about 12.9 million m^3/yr (456 million ft^3/yr) (King 1997a:5).

3.4.11.1.4 Water

Water for Pantex is provided by a system of five wells, together with pumps and storage tanks. The volume used by the plant between 1989 and 1995 ranged from 689 million l (182 million gal) to 946 million l (250 million gal) (M&H 1996a:9-7). The water supply system capacity is about 3.8 billion l/yr (1 billion gal/yr); the average usage of domestic water, about 850 million l/yr (225 million gal/yr) (King 1997a:5).

3.4.11.1.5 Site Safety Services

Plant fire protection is provided by the Pantex fire department, which has one onsite fire station. Personnel in the fire department maintain a high level of readiness. A minimum of eight firefighters, three of whom are certified paramedics, are on duty at all times. The fire department maintains two advanced life-support ambulances on the site (M&H 1996a:9-25).

3.4.11.2 Proposed Facility Location

Little current utility usage occurs in Zone 4 West. Given the current usage level of each utility type at Pantex, excess capacity available for Zone 4 West would be as indicated in Table 3–37. There would be an electrical capacity of 338,634 MWh/yr, with a peak load of 110.4 MW; a natural gas capacity of about 235 million m^3/yr (8.3 billion ft^3/yr); and a water capacity of about 3 billion l/yr (775 million gal/yr), with a peak supply of about 8 million l/day (2 million gal/day) (King 1997a:6).

Table 3–37. Pantex Infrastructure Characteristics for Zone 4

Resource	Current Usage	Excess Site Capacity
Electrical		
Energy consumption (MWh/yr)	Negligible	338,634
Peak load (MW)	Negligible	110.4
Fuel		
Natural gas (m^3/yr)	Negligible	235,181,309
Oil (l/yr)	NA	NA[a]
Coal (t/yr)[b]	NA[b]	NA[b]
Water (l/yr)	Negligible	2,933,000,000

[a] As supplies get low, more can be supplied by truck or rail.

[b] Coal is not used at Pantex.

Key: NA, not applicable.

Source: King 1997a:6.

3.5 SRS

SRS is about 19 km (12 mi) south of Aiken, South Carolina (Figure 2–5). First established in 1950, SRS has been involved for more than 40 years in tritium operations and nuclear material production. Today the site includes 16 major production, service, and R&D areas, not all of which are currently in operation (DOE 1996a:3-228).

There are more than 3,000 facilities at SRS, including 740 buildings with 511,000 m^2 (5.5 million ft^2) of floor area. Major nuclear facilities at SRS include fuel and plutonium storage facilities and target fabrication facilities, nuclear material production reactors, chemical separation 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. Tritium recycling facilities at SRS empty tritium from expired reservoirs, purify it to eliminate the helium decay product, and fill replacement reservoirs for nuclear 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 none has been produced since 1988 (DOE 1996a:3-228).

DOE Activities. The current missions at SRS are shown in Table 3–38. In the past, the SRS complex produced nuclear materials. The complex consisted of various plutonium 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 F- and H-Canyons are planned to be used through the year 2002 to complete DOE's commitment to the Defense Nuclear Facilities Safety Board regarding stabilization of inventories of unstable nuclear materials (DOE 1996a:3-228).

Table 3–38. Current Missions at SRS

Mission	Description	Sponsor
Plutonium storage	Maintain F-Area plutonium 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 management 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 Defense Programs, Environmental Management, and Nuclear Energy programs	Assistant Secretary for Defense Programs; Assistant Secretary for Environmental Management; Office of Nuclear Energy

Source: DOE 1996a:3-229.

DOE Office of Environmental Management is pursuing a 10-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; remedied contaminated groundwater; and dispose of surplus facilities (DOE 1996a:3-228).

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 (DOE 1996a:3-228).

Non-DOE 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 plans and provides continual support with site layout and vegetative management. It also assists in long-term wildlife management and soil rehabilitation projects (DOE 1996a:3-228).

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 gain 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 (DOE 1996a:3-229).

3.5.1 Air Quality and Noise

3.5.1.1 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. Air pollutants are transported, dispersed, or concentrated by meteorological and topographical conditions. Air quality is affected by air pollutant emission characteristics, meteorology, and topography.

3.5.1.1.1 General Site Description

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, moist maritime air masses. The average annual temperature at SRS is 17.3 EC (63.2 EF); temperatures vary from an average daily minimum of 0 EC (32 EF) in January to an average daily maximum of 33.2 EC (91.7 EF) in July. The average annual precipitation at SRS is about 114 cm (45 in). Precipitation is distributed fairly evenly throughout the year, with the highest in summer and the lowest in autumn. There is no predominant wind direction at SRS. The average annual wind speed at Augusta National Weather Service Station is 2.9 m/s (6.5 mph) (NOAA 1994b). Additional information related to meteorology and climatology at SRS is presented in Appendix F of the *Storage and Disposition PEIS* (DOE 1996a:F-16, F-17) and in the *Savannah River Site Waste Management Environmental Impact Statement* (DOE 1995c:3-21–3-25).

SRS is near the center of the Augusta-Aiken Interstate AQCR #53. None of the areas within SRS and its surrounding counties are designated as nonattainment areas with respect to the NAAQS for criteria air pollutants (EPA 1997f; 1997g). Applicable NAAQS and the ambient air quality standards for the States of South Carolina and Georgia are presented in Table 3–39.

Table 3–39. Comparison of Ambient Air Concentrations From SRS Sources With Most Stringent Applicable Standards or Guidelines, 1994

Pollutant	Averaging Period	Most Stringent Standard or Guideline (Fg/m³)[a]	Concentration (Fg/m³)
Criteria pollutants			
Carbon monoxide	8 hours	10,000[b]	632
	1 hour	40,000[b]	5,010
Nitrogen dioxide	Annual	100[b]	8.8
Ozone	8 hours	157[c]	(d)
PM_{10}	Annual	50[b]	4.8
	24 hours	150[b]	80.6
$PM_{2.5}$	3-year annual	15[c]	(e)
	24 hours (98th percentile over 3 years)	65[c]	(e)
Sulfur dioxide	Annual	80[b]	16.3
	24 hours	365[b]	215
	3 hours	1,300[b]	690
Lead	Calendar quarter	1.5[b]	<0.01
Other regulated pollutants			
Gaseous fluoride	30 days	0.8[f]	(g)
	7 days	1.6[f]	0.11
	24 hours	2.9[f]	0.60
	12 hours	3.7[f]	241
Total suspended particulates	Annual	75[f]	43.3
Hazardous and other toxic compounds			
Benzene	24 hours	150[f]	20.7
[Text deleted.]			

[a] The more stringent of the Federal and State standards is presented if both exist for the averaging period. The National Ambient Air Quality Standards (NAAQS) (EPA 1997a), other than those for ozone, particulate matter, and lead, and those based on annual averages, are not to be exceeded more than once per year. The 1-hr ozone standard is attained when the expected number of days per year with maximum hourly average concentrations above the standard is #1. The 1-hr ozone standard applies only to nonattainment areas. The 8-hr ozone standard is attained when the 3-year average of the annual fourth-highest daily maximum 8-hr average concentration is less than or equal to 157 Fg/m³. The 24-hr particulate matter standard is attained when the expected number of days with a 24-hr average concentration above the standards is #1. The annual arithmetic mean particulate matter standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard.

[b] Federal and State standard.

[c] Federal standard.

[d] Not directly emitted or monitored by the site.

[e] No data is available with which to assess $PM_{2.5}$ concentrations.

[f] State standard.

[g] No concentration reported.

Note: The NAAQS also includes standards for lead. No sources of lead emissions have been identified for any of the alternatives presented in Chapter 4. Emissions of other air pollutants not listed here have been identified at SRS, but are not associated with any of the alternatives evaluated. These other air pollutants are quantified in the *Storage and Disposition PEIS* (DOE 1996a). EPA recently revised the ambient air quality standards for particulate matter and ozone. The new standards, finalized on July 18, 1997, changed the ozone primary and secondary standards from a 1-hr concentration of 235 Fg/m³ (0.12 ppm) to an 8-hr concentration of 157 Fg/m³ (0.08 ppm). During a transition period while States are developing State implementation plan revisions for attaining and maintaining these standards, the 1-hr ozone standard will continue to apply in nonattainment areas (EPA 1997b:38855). For

particulate matter, the current PM_{10} annual standard is retained, and two $PM_{2.5}$ standards are added. These standards are set at a 15-Fg/m^3 3-year annual arithmetic mean based on community-oriented monitors and a 65-F g/m^3 3-year average of the 98th percentile of 24-hr concentrations at population-oriented monitors. The revised 24-hr PM_{10} standard is based on the 99th percentile of 24-hr concentrations. The existing PM_{10} standards will continue to apply in the interim period (EPA 1997c:38652). Values may differ from those of the source document due to rounding.
Source: DOE 1998e:3-14, 1998f:3-26; EPA 1997a; SCDHEC 1996.

There are no PSD Class I areas within 100 km (62 mi) of SRS. None of the facilities at SRS have been required to obtain a PSD permit (DOE 1996a:3-233).

The primary emission sources of criteria air pollutants at SRS are the nine coal-burning boilers and four fuel-oil-burning package boilers that produce steam and electricity, diesel engine-powered equipment, the Defense Waste Processing Facility (DWPF), the In-Tank Precipitation process, groundwater air strippers, the Consolidated Incineration Facility, and various other process facilities. Other emissions and sources include fugitive particulates from coal piles and coal-processing facilities, vehicles, controlled burning of forestry areas, and temporary emissions from various construction-related activities (DOE 1996a:F-17, F-18).

Table 3–39 presents the ambient air concentrations attributable to sources at SRS. These concentrations are based on emissions for the year 1994 (DOE 1998e:3-14; DOE 1998f:3-26). Only those hazardous pollutants that would be emitted for any of the surplus plutonium disposition alternatives are presented. Additional information on ambient air quality at SRS is in the *SRS Environmental Report for 1995* (Arnett and Mamatey 1996:111–114). Concentrations shown in Table 3–39 attributable to SRS are in compliance with applicable guidelines and regulations. Data for 1995 from nearby South Carolina monitors at Beech Island, Jackson, and Barnwell indicate that the NAAQS for particulate matter, lead, ozone, sulfur dioxide, and nitrogen dioxide are not exceeded in the area around SRS (SCDHEC 1995:1, 25, 28, 37–39). Air pollutant measurements at these monitoring locations during 1995 showed for nitrogen dioxide an annual average concentration of 9.4 Fg/m^3; for sulfur dioxide concentrations of 99 Fg/m^3 for 3-hr averaging, 24 Fg/m^3 for 24-hr averaging, and 5 Fg/m^3 for the annual average; for total suspended particulates an annual average concentration of 37 Fg/m^3; and for PM_{10} concentrations of 62 Fg/m^3 for 24-hr averaging and 19 Fg/m^3 for the annual average.

3.5.1.1.2 Proposed Facility Locations

The meteorological conditions described for SRS are considered representative of F-Area. Information on air pollutant emissions from F-Area is included in the overall site emissions discussed previously.

The meteorological conditions described for SRS are considered representative of S-Area. Information on air pollutant emissions from S-Area is included in the previous discussion of overall site emissions. The air pollutant sources in this area include process and diesel generator emissions.

3.5.1.2 Noise

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.

3.5.1.2.1 General Site Description

Major noise sources at SRS are primarily in developed or active areas and include various industrial facilities, equipment, and machines (e.g., 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 (DOE 1996a:3-233–3-235).

Another important contributor to noise levels is traffic to and from SRS operations along 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-hr equivalent sound level from traffic ranged from 48 to 72 dBA. The estimated day-night average sound levels along this route were 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-hr equivalent sound level from traffic ranged from 53 to 71 dBA. The estimated average day-night average sound levels along this route were 68 dBA for summer and 67 dBA for winter (NUS 1990:3-2–3-6, app. C and F).

Most industrial facilities at SRS are far enough from the site boundary that noise levels from these sources at the boundary would not be measurable or would be barely distinguishable from background 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 that limits daytime and nighttime noise by frequency band (DOE 1996a:F-33).

The EPA guidelines for environmental noise protection recommend an average day-night average sound level of 55 dBA as sufficient to protect the public from the effects of broadband environmental noise in typically quiet outdoor and residential areas (EPA 1974:29). Land-use compatibility guidelines adopted by the Federal Aviation Administration and the Federal Interagency Committee on Urban Noise indicate that yearly day-night average sound levels less than 65 dBA are compatible with residential land uses and levels up to 75 dBA are compatible with residential uses if suitable noise reduction features are incorporated into structures (DOT 1995). It is expected that for most residences near SRS, the day-night average sound level is less than 65 dBA and is compatible with the residential land use, although for some residences along major roadways noise levels may be higher.

3.5.1.2.2 Proposed Facility Locations

No distinguishing noise characteristics at F-Area have been identified. F-Area is far enough—7.9 km (4.9 mi)—from the site boundary that noise levels from the facilities are not measurable or are barely distinguishable from background levels.

No distinguishing noise characteristics at S-Area have been identified. Observations of sound sources during a summer sound level survey near the fence line of S-Area indicate that typical sources include vehicles, turbines, locomotives, paging systems, and fans (NUS 1990:app. B). S-Area is far enough—9.6 km (6 mi)—from the site boundary that noise levels from these facilities are not measurable or are barely distinguishable from background levels.

3.5.2 Waste Management

Waste management includes minimization, characterization, treatment, storage, transportation, and disposal of waste generated from ongoing DOE activities. The waste is managed according to appropriate treatment, storage, and disposal technologies and in compliance with all applicable Federal and State statutes and DOE orders.

3.5.2.1 Waste Inventories and Activities

SRS manages the following types of waste: HLW, TRU, mixed TRU, LLW, mixed LLW, hazardous, and nonhazardous. HLW would not be generated by surplus plutonium disposition activities at SRS, and therefore, will not be discussed further. Waste generation rates and the inventory of stored waste from activities at SRS are provided in Table 3–40. Table 3–41 summarizes the SRS waste management capabilities. More detailed

Table 3–40. Waste Generation Rates and Inventories at SRS

Waste Type	Generation Rate (m^3/yr)	Inventory (m^3)
TRU[a]		
Contact handled	427	6,977
Remotely handled	4	0
LLW	10,043	1,616
Mixed LLW		
RCRA	1,135	6,940
TSCA	0	110
Hazardous	74	1,416[b]
Nonhazardous		
Liquid	416,100	NA[c]
Solid	6,670	NA[c]

[a] Includes mixed TRU wastes.

[b] Sessions 1997a.

[c] Generally, nonhazardous wastes are not held in long-term storage.

Key: LLW, low-level waste; NA, not applicable; RCRA, Resource Conservation and Recovery Act; TRU, transuranic; TSCA, Toxic Substances Control Act.

Source: DOE 1996d:15, 16, except for hazardous and nonhazardous solid waste (DOE 1996a:3-262, 3-263) and nonhazardous liquid waste (Sessions 1997a).

descriptions of the waste management system capabilities at SRS are included in the *Storage and Disposition PEIS* (DOE 1996a:3-261–3-265, E-97) and the *Savannah River Site Waste Management Final EIS* (DOE 1995c:3-66).

EPA placed SRS on the National Priorities List in December 1989. In accordance with CERCLA, DOE entered into an FFCA with EPA and the State of South Carolina to coordinate cleanup activities at SRS under one comprehensive strategy. The FFCA combines the RCRA Facility Investigation Program Plan with a CERCLA cleanup program titled the *RCRA Facility Investigation/Remedial Investigation Program Plan* (DOE 1996a:3-261). More information on regulatory requirements for waste disposal is provided in Chapter 5.

3.5.2.2 Transuranic and Mixed Transuranic Waste

TRU waste generated between 1974 and 1986 is stored on five concrete pads and one asphalt pad that have been covered with approximately 1.2 m (4 ft) of soil. TRU waste generated since 1986 is stored on 13 concrete pads that are not covered with soil. The TRU waste storage pads are in the Low-Level Radioactive Waste Disposal Facility (DOE 1995c:3-80, 3-81).

A TRU Waste Characterization and Certification Facility is planned and would provide extensive containerized waste certification capabilities. The facility is needed to prepare TRU waste for treatment and to certify TRU waste for disposal at WIPP. Drums that are certified for shipment to WIPP will be placed in interim storage

on concrete pads in E-Area (DOE 1996a:3-264). LLW containing concentrations of TRU nuclides between 10 and 100 nCi (referred to as alpha-contaminated LLW) is managed like TRU waste because its physical and chemical properties are similar and similar procedures will be used to determine its final disposition (DOE 1996a:3-264). WIPP is expected to begin receiving waste from SRS in 2000 (Aragon 1999).

Table 3–41. Waste Management Capabilities at SRS

Facility Name/Description	Capacity	Status	Applicable Waste Type					
			TRU	Mixed TRU	LLW	Mixed LLW	Haz	Non-Haz
Treatment Facility (m^3/yr)								
TRU Waste Characterization/ Certification Facility	1,720	Planned for 2007	X	X				
Consolidated Incineration Facility & Ashcrete Stabilization Facility	4,630 liquid 17,830 solid	Online			X	X	X	
F- and H-Area Effluent Treatment Facility	1,930,000	Online			X	X		
M-, L-, and H-Area Compactors	3,983	Online			X			
Non-Alpha Vitrification Facility	3,090	Planned			X	X	X	
M-Area Liquid Effluent Treatment Facility	999,000	Online				X		
M-Area Vendor Treatment Facility	2,470	Planned				X		
Savannah River Technology Center Ion Exchange Treatment Probe	11,200	Online				X		
E-Area Supercompactor	5,700	Planned			X			
Z-Area Saltstone Facility	28,400	Online				X		
Central Sanitary Wastewater Treatment Facility	1,449,050	Online						X
Storage Facility (m^3)								
TRU Storage Pads	34,400	Online	X	X				
DWPF Organic Waste Storage Tank	568	Online				X		
Liquid Waste Solvent Tanks	454	Planned				X		
M-Area Process Waste Interim Treatment/Storage Facility	8,300	Online				X		
Mixed Waste Storage Facilities (645-2N, -295, -43E)	1,905	Online				X		
Savannah River Technology Center Mixed Waste Storage Tanks	198	Online				X		
Long-Lived Waste Storage Building	1,064	Planned			X			
Solid Waste Storage Pads	2,657	Online				X	X	
Buildings 316-M, 710-B, 645-N, and 645-4N	2,515	Online				X	X	
M-Area Storage Pad	2,160	Online				X		
Disposal Facility (m^3)								
Intermediate-Level Waste Vaults	3,665	Online			X			
Low-Activity Waste Vaults	30,500	Online			X			
LLW Disposal Facility Slit Trenches	26,000	Planned			X			
Z-Area Saltstone Vaults	1,110,000	Online			X			

Key: DWPF, Defense Waste Processing Facility; Haz, hazardous; LLW, low-level waste; TRU, transuranic.
Source: DOE 1996a:E-108–E-112; Miles 1998; Rhoderick 1998; Sessions 1997a, 1997b.

3.5.2.3 Low-Level Waste

Both liquid and solid LLW are treated at SRS. Most aqueous LLW streams are sent to the F- and H-Area Effluent Treatment Facility and treated by filtration, reverse osmosis, and ion exchange to remove the radionuclide contaminants. After treatment, the effluent is discharged to Upper Three Runs Creek. The treatment residuals are concentrated by evaporation and stored in the H-Area tank farm for eventual treatment in the Z-Area Saltstone Facility. In that facility, wastes are immobilized with grout for onsite disposal (DOE 1996a:E-98).

After completion of a series of extensive readiness tests, the Consolidated Incineration Facility began radioactive operations in 1997. The Consolidated Incineration Facility is designed to incinerate both solid and liquid LLW, mixed LLW, and hazardous waste (WSRC 1997a).

Solid LLW is segregated into several categories to facilitate proper treatment, storage, and disposal. Solid LLW that radiates less than 200 mrem/hr at 5 cm (2 in) from the unshielded container is considered low-activity waste. If it radiates greater than 200 mrem/hr at 5 cm (2 in), it is considered intermediate-activity waste. Intermediate-activity tritium waste is intermediate-activity waste with more than 10 Ci of tritium per container. Long-lived waste is contaminated with long-lived isotopes that exceed the waste acceptance criteria for onsite disposal (DOE 1996a:E-99).

Four basic types of vaults and buildings are used for storing the different waste categories: low-activity waste vaults, intermediate-level nontritium vaults, intermediate-level tritium vaults, and the long-lived waste storage building. The vaults are below-grade concrete structures, and the storage building is a metal building on a concrete pad (DOE 1996a:E-99).

Currently, DOE places low-activity LLW in carbon steel boxes and deposits them in the low-activity waste vaults in E-Area. Intermediate-activity LLW is packaged according to waste form and disposed of in the intermediate-level waste vaults in E-Area. Long-lived wastes are stored in the Long-Lived Waste Storage Building in E-Area until treatment and disposal technologies are developed (DOE 1995c:3-75).

Saltstone generated in the solidification of LLW salts extracted from HLW is disposed of in the Z-Area Saltstone Vaults. Saltstone is solidified grout formed by mixing the LLW salt with cement, fly ash, and furnace slag. Saltstone is the highest volume of solid LLW disposed of at SRS. SRS disposal facilities are projected to meet solid LLW disposal requirements, including LLW from off the site, for the next 20 years (DOE 1996a:3-261, 3-264).

3.5.2.4 Mixed Low-Level Waste

The FFCA addresses SRS compliance with RCRA LDR. The FFCA requires DOE facilities storing mixed waste to develop site-specific treatment plans and to submit them for approval (DOE 1996a:3-264, 3-265). The site treatment plan for mixed waste specifies treatment technologies or technology development schedules for all SRS mixed waste (Arnett and Mamatey 1996:50). SRS is allowed to continue to generate and store mixed waste, subject to LDR. Schedules to provide compliance through treatment in the Consolidated Incineration Facility are included in the FFCA (DOE 1996a:3-264).

The SRS mixed waste program consists primarily of safely storing waste until treatment and disposal facilities are available. Mixed LLW is stored in the A-, E-, M-, N-, and S-Areas in various tanks and buildings. These facilities include burial ground solvent tanks, the M-Area Process Waste Interim Treatment/Storage Facility, the Savannah River Technology Center Mixed Waste Storage Tanks, and the DWPF Organic Waste Storage Tank (DOE 1995c:3-81). These South Carolina Department of Health and Environmental Control permitted facilities will remain in use until appropriate treatment and disposal is performed on the waste (DOE 1996a:E-99).

3.5.2.5 Hazardous Waste

Hazardous waste is accumulated at the generating facility for a maximum of 90 days, or stored in DOT-approved containers in three RCRA-permitted hazardous waste storage buildings and on three interim status storage pads in B- and N-Areas. Most of the waste is shipped off the site to commercial RCRA-permitted treatment and disposal facilities using DOT-certified transporters. DOE plans to incinerate up to 9 percent of the hazardous waste (organic liquids, sludge, and debris) in the Consolidated Incineration Facility (DOE 1996a:3-265). In 1995, 72 m^3 (2,538 ft^3) of hazardous waste were sent to onsite storage. Of this amount, 20 m^3 (712 ft^3) were shipped off the site for commercial treatment or disposal (Arnett and Mamatey 1996:48).

3.5.2.6 Nonhazardous Waste

In 1994, the centralization and upgrading of the sanitary wastewater collection and treatment systems at SRS were completed. The program included the replacement of 14 (of 20) aging treatment facilities scattered across the site with a new 3,975 m^3/day (1.1 million gal/day) central treatment facility and connecting them with a new 29 km (18 mi) sanitary sewer system. The central treatment facility treats sanitary wastewater by the extended aeration activated sludge process. The treatment facility separates the wastewater into two forms, clarified effluent and sludge. The liquid effluent is further treated by the nonchemical method of ultraviolet (UV) light disinfection to meet NPDES discharge limitations for the outfall to Fourmile Branch. The sludge is further treated to reduce pathogen levels to meet proposed land application criteria. The remaining sanitary wastewater treatment facilities are being upgraded as necessary by replacing existing chlorination treatment systems with nonchemical UV light disinfection systems to meet NPDES limitations (DOE 1996a:3-265).

SRS has privatized the collection, hauling, and disposal of its sanitary waste (Arnett and Mamatey 1996:48). SRS-generated solid sanitary waste is sent to the Three Rivers Landfill (DOE 1998f:3-42). SRS disposes of other nonhazardous waste that consists of scrap metal, powerhouse ash, domestic sewage, scrap wood, construction debris, and used railroad ties in a variety of ways. Scrap metal is sold to salvage vendors for reclamation. Powerhouse ash and domestic sewage sludge are used for land reclamation. Scrap wood is burned on the site or chipped for mulch. Construction debris is used for erosion control. Railroad ties are shipped off the site for disposal (DOE 1996a:E-100).

3.5.2.7 Waste Minimization

The total amount of waste generated and disposed of at SRS has been and continues to be reduced through the efforts of the pollution prevention and waste minimization program at the site. This program is designed to achieve continuous reduction of waste and pollutant releases to the maximum extent feasible and in accordance with regulatory requirements while fulfilling national security missions (DOE 1996a:E-97). The program focuses mainly on source reduction, recycling, and increasing employee participation in pollution prevention. For example, 1995 nonhazardous solid waste generation was 32 percent below that of 1994, and the disposal volume of other solid waste, including radioactive and hazardous wastes, was 38 percent below 1994 levels. In 1995, SRS achieved a 9 percent reduction in its radioactive waste generation volume compared with 1994. Total solid waste volumes have declined by more than 70 percent since 1991. Radioactive solid waste volumes have declined by about 63 percent, or more than 17,000 m^3 (600,000 ft^3) from 1991 through 1995. In 1995, more than 2,990 t (3,300 tons) of nonradioactive materials were recycled at SRS, including 963 t (1,062 tons) of paper and cardboard (Arnett and Mamatey 1996:16, 41).

3.5.2.8 Preferred Alternatives From the Final WM PEIS

Preferred alternatives from the WM PEIS (DOE 1997a:summary, 117) are shown in Table 3–42 for the four waste types analyzed in this SPD EIS. A decision on the future management of these wastes could result in the

construction of new waste management facilities at SRS and the closure of other facilities. Decisions on the various waste types are expected to be announced in a series of RODs to be issued on this WM PEIS. In fact, the TRU waste ROD was issued on January 20, 1998 (DOE 1998a), with the hazardous waste ROD issued on August 5, 1998 (DOE 1998b). The TRU waste ROD states that DOE will develop and operate mobile and fixed facilities to characterize and prepare TRU waste for disposal at WIPP. Each DOE site that has, or will generate, TRU waste will, as needed, prepare and store its TRU waste on the site. The hazardous waste ROD states that

Table 3–42. Preferred Alternatives From the WM PEIS

Waste Type	Preferred Action
TRU and mixed TRU	DOE prefers the regionalized alternative for onsite treatment and storage of SRS contact-handled TRU waste. Under this alternative, some contact-handled TRU waste could be received from ORR for treatment and storage.[a]
LLW	DOE prefers to treat SRS LLW on the site. SRS could be selected as one of the regional disposal sites for LLW.
Mixed LLW	DOE prefers regionalized treatment at SRS. This includes the onsite treatment of SRS waste and could include treatment of some mixed LLW generated at other sites. SRS could be selected as one of the regional disposal sites for mixed LLW.
Hazardous	DOE prefers to continue to use commercial facilities for hazardous waste treatment.[b]

[a] ROD for TRU waste (DOE 1998a) states that "each of the Department's sites that currently has or will generate TRU waste will prepare and store its TRU waste on site. . . ."

[b] ROD for hazardous waste (DOE 1998b) selected a modified preferred alternative that includes continued onsite treatment at SRS where this is economically favorable.

Key: LLW, low-level waste; ORR, Oak Ridge Reservation; TRU, transuranic.

Source: DOE 1997a:summary, 117.

most DOE sites will continue to use offsite facilities for the treatment and disposal of major portions of the nonwastewater hazardous waste, with ORR and SRS continuing to treat some of their own hazardous waste on the site in existing facilities where this is economically favorable. More detailed information and DOE's alternatives for the future configuration of waste management facilities at SRS is presented in the WM PEIS and the hazardous waste and TRU waste RODs.

3.5.3 Socioeconomics

Statistics for employment and regional economy are presented for the REA as defined in Appendix F.9, which encompasses 15 counties around SRS located in Georgia and South Carolina. Statistics for population, housing, community services, and local transportation are presented for the ROI, a five-county area in which 90.7 percent of all SRS employees reside as shown in Table 3–43. In 1997, SRS employed 15,032 persons (about 5.8 percent of the REA civilian labor force) (Knox 1997).

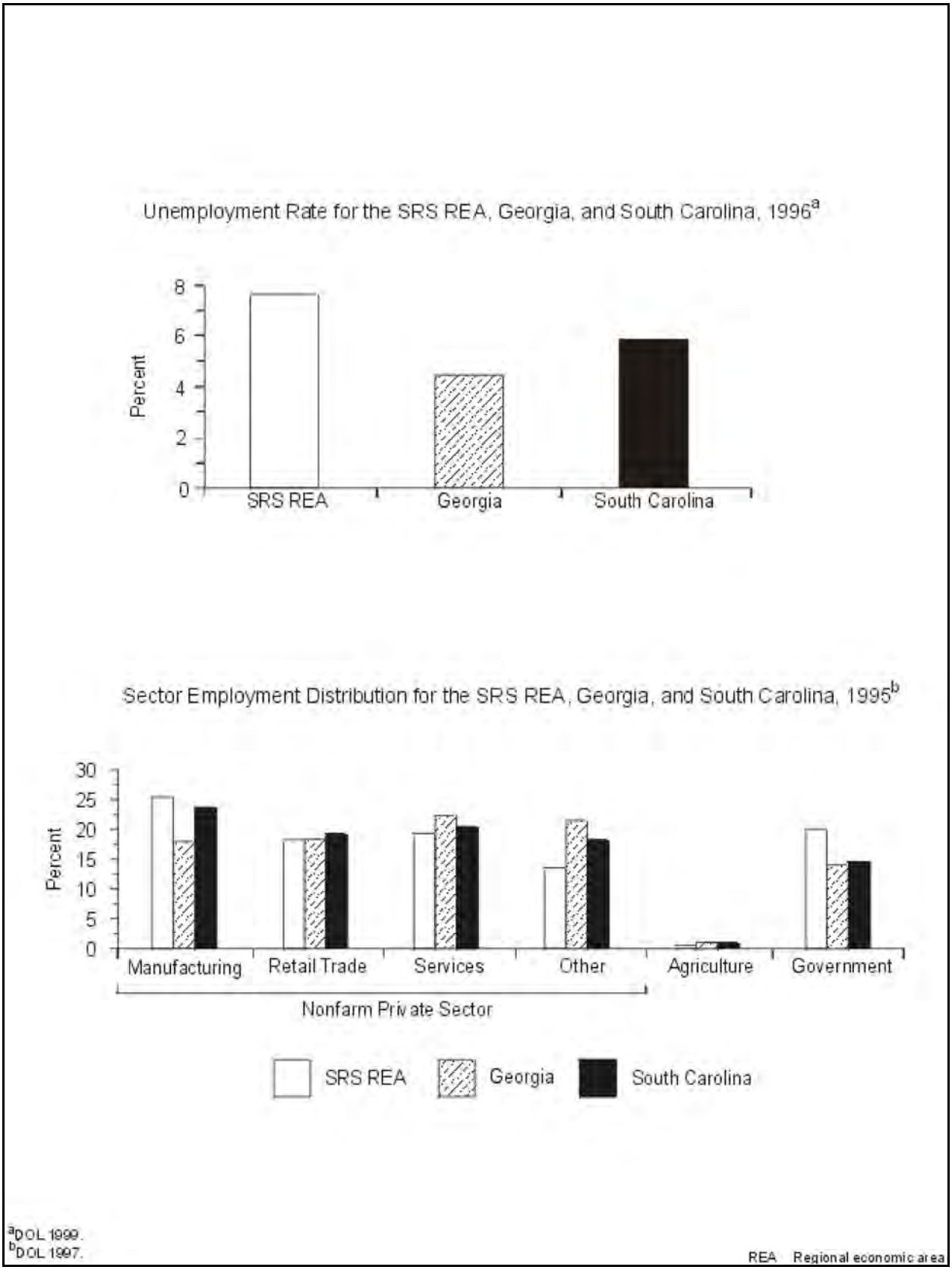
Table 3–43. Distribution of Employees by Place of Residence in the SRS Region of Influence, 1997

County	Number of Employees	Total Site Employment (Percent)
Aiken	6,981	53.9
Columbia	1,881	14.5
Richmond	1,755	13.5
Barnwell	932	7.2
Edgefield	210	1.6
ROI total	11,759	90.7

Source: Knox 1997.

3.5.3.1 Regional Economic Characteristics

Selected employment and regional economy statistics for the SRS REA are summarized in Figure 3–26. Between 1990 and 1996, the civilian labor force in the REA increased 3.6 percent to the 1996 level of 257,101. In 1996, the unemployment rate in the REA was 7.6 percent, which is greater than the unemployment rates for Georgia (4.6 percent) and South Carolina (6 percent) (DOL 1999).



[a]DOL 1999.
[b]DOL 1997.

REA Regional economic area

Figure 3–26. Employment and Local Economy for the SRS Regional Economic Area and the States of Georgia and South Carolina

In 1995, manufacturing represented the largest sector of employment in the REA (25.6 percent). This was followed by government (20.9 percent) and service (19.9 percent) activities. The total for these employment sectors in Georgia was 17.5 percent, 16.8 percent, and 23 percent, respectively. The total for these employment sectors in South Carolina was 23.3 percent, 17.3 percent, and 20.5 percent, respectively (DOL 1997).

3.5.3.2 Population and Housing

In 1996, the ROI estimated population totaled 453,778. From 1990 to 1996, the ROI population increased by 8.6 percent, compared with a 13 percent increase in Georgia's population and a 5.7 percent increase in South Carolina's population (DOC 1997). Between 1980 and 1990, the number of housing units in the ROI increased by 25.1 percent, compared with the 30.1 percent increase in Georgia and the 23.5 percent increase in South Carolina. The total number of housing units within the ROI for 1990 was 165,443 (DOC 1994). The 1990 homeowner vacancy rate for the ROI was 2.2 percent, compared with the statewide rates of 2.5 percent for Georgia and 1.7 percent for South Carolina. The renter vacancy rate for the ROI counties was 10 percent compared with the statewide rates of 12.2 percent for Georgia and 11.5 percent for South Carolina (DOC 1990a). Population and housing trends are summarized in Figure 3–27.

3.5.3.3 Community Services

3.5.3.3.1 Education

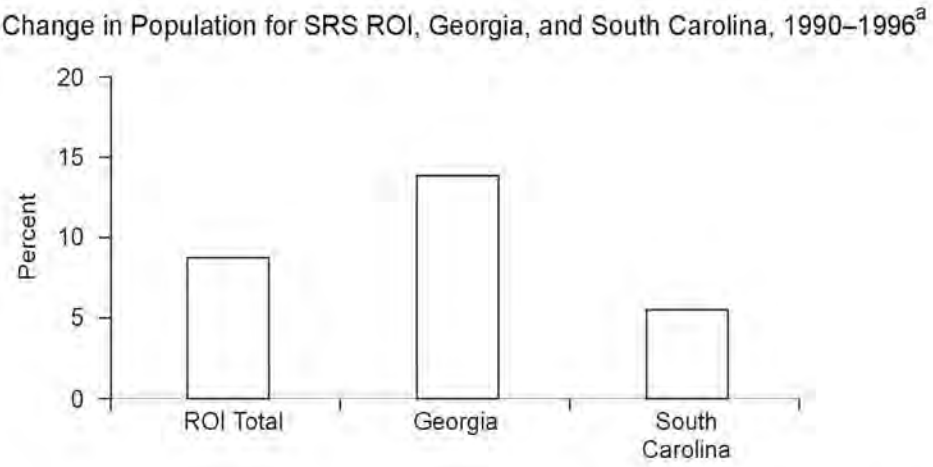
Seven school districts provided public education services and facilities in the SRS ROI. As shown in Figure 3–28, these school districts operated at between 85 percent (Barnwell County, District 19) and 125 percent (Richmond County School District) capacity in 1997. In 1997, the average student-to-teacher ratio for the SRS ROI was 17:1 (Nemeth 1997a). In 1990, the average student-to-teacher ratios were 10.8:1 for Georgia and 11.5:1 for South Carolina (DOC 1990b; 1994).

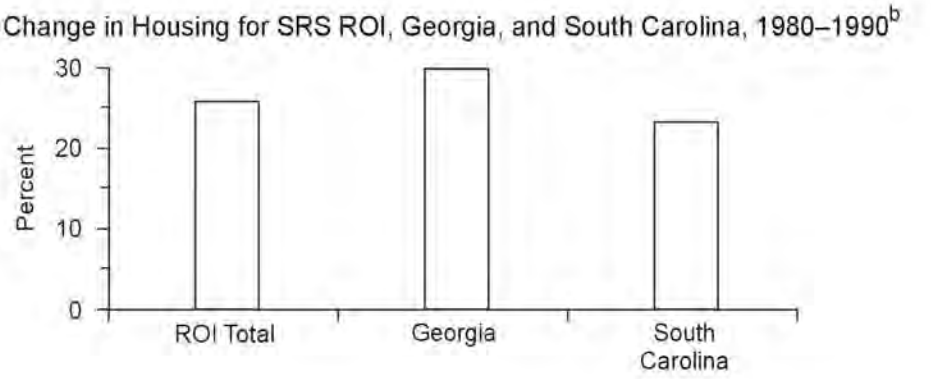
3.5.3.3.2 Public Safety

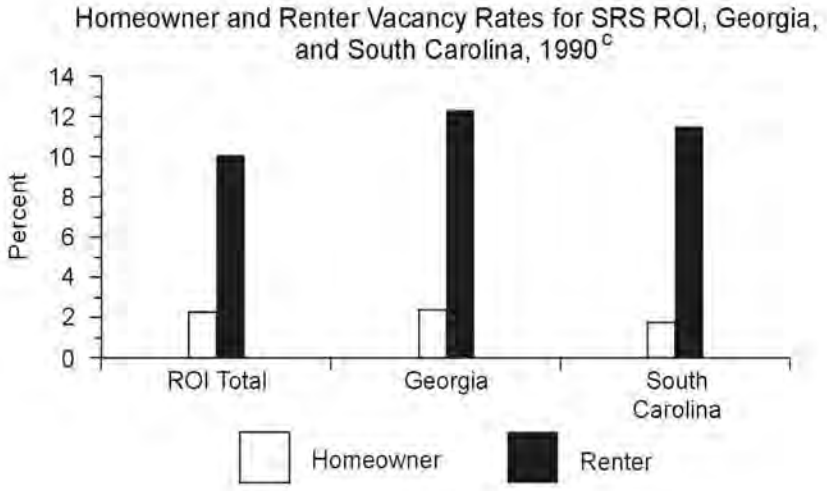
In 1997, a total of 973 sworn police officers were serving the five-county ROI. The average ROI officer-to-population ratio was 2.1 officers per 1,000 persons (Nemeth 1997b). This compares with the 1990 State averages of 2.0 officers per 1,000 persons for Georgia and 1.8 officers per 1,000 persons for South Carolina (DOC 1990b). In 1997, 1,712 paid and volunteer firefighters provided fire protection services in the SRS ROI. The average firefighter-to-population ratio in the ROI was 3.8 firefighters per 1,000 persons (Nemeth 1997b). This compares with the 1990 State averages of 1.0 firefighters per 1,000 persons for Georgia and 0.8 firefighters per 1,000 persons for South Carolina (DOC 1990b). Figure 3–29 displays the ratio of sworn police officers and firefighters to the population for all the counties in the ROI.

3.5.3.3.3 Health Care

In 1996, a total of 1,722 physicians served the ROI. The average physician-to-population ratio in the ROI was 3.8 physicians per 1,000 persons. This compares with a 1996 State average of 2.3 physicians per 1,000 persons for Georgia and 2.2 physicians per 1,000 persons for South Carolina (Randolph 1997). In 1997, there were 10 hospitals serving the five-county ROI. The hospital bed-to-population ratio averaged 7.7 beds per 1,000 persons (Nemeth 1997c). This compares with a 1990 State average of 4.1 beds per 1,000 persons for Georgia and 3.3 beds per 1,000 persons for South Carolina (DOC 1996:128). Figure 3–29 displays the hospital bed-to-population and physician-to-population ratios for the SRS ROI counties.







[a]DOC 1997.
[b]DOC 1994.
[c]DOC 1990a.

ROI Region of influence

Figure 3–27. Population and Housing for the SRS Region of Influence and the States of Georgia and South Carolina

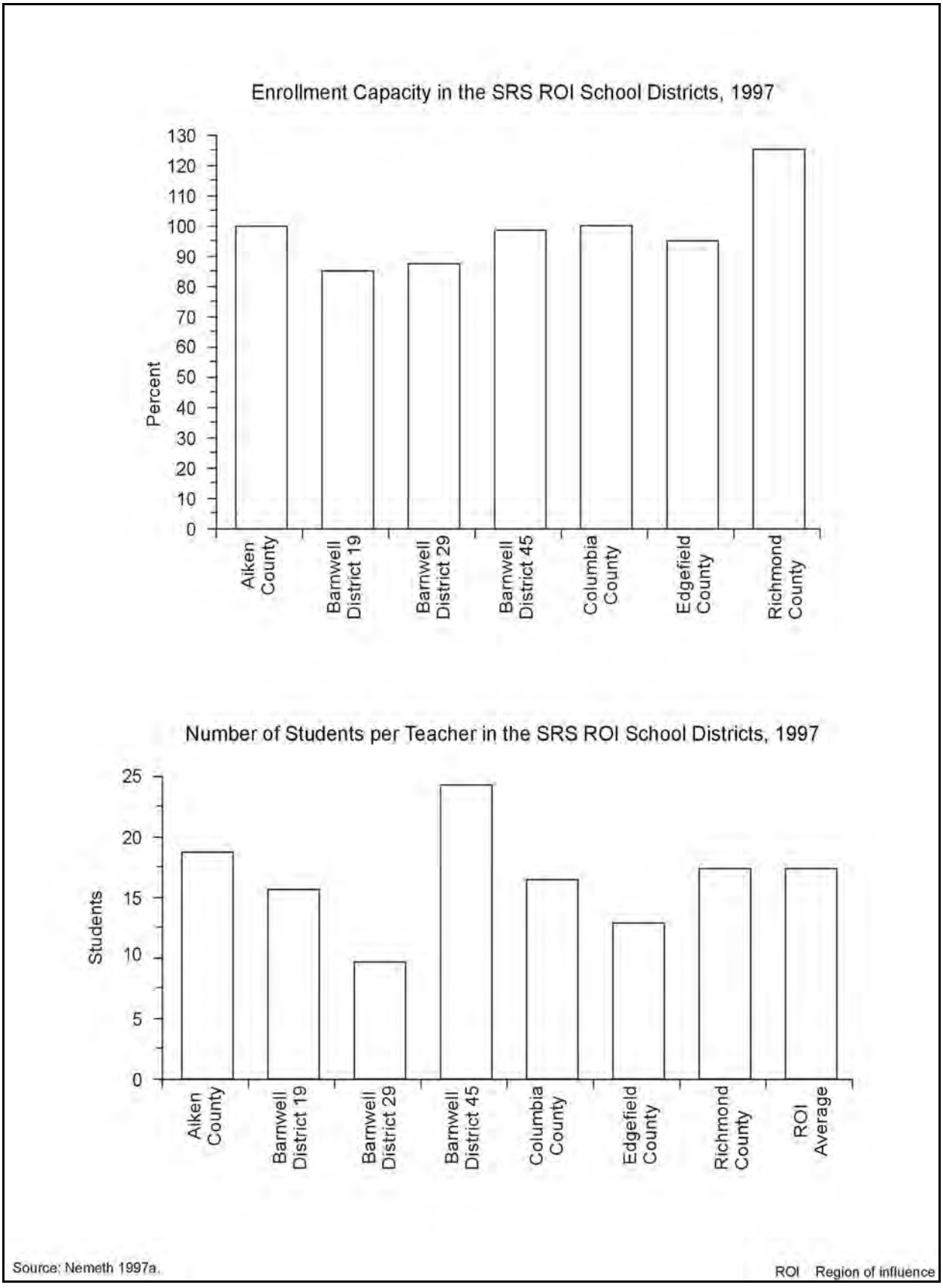


Figure 3–28. School District Characteristics for the SRS Region of Influence

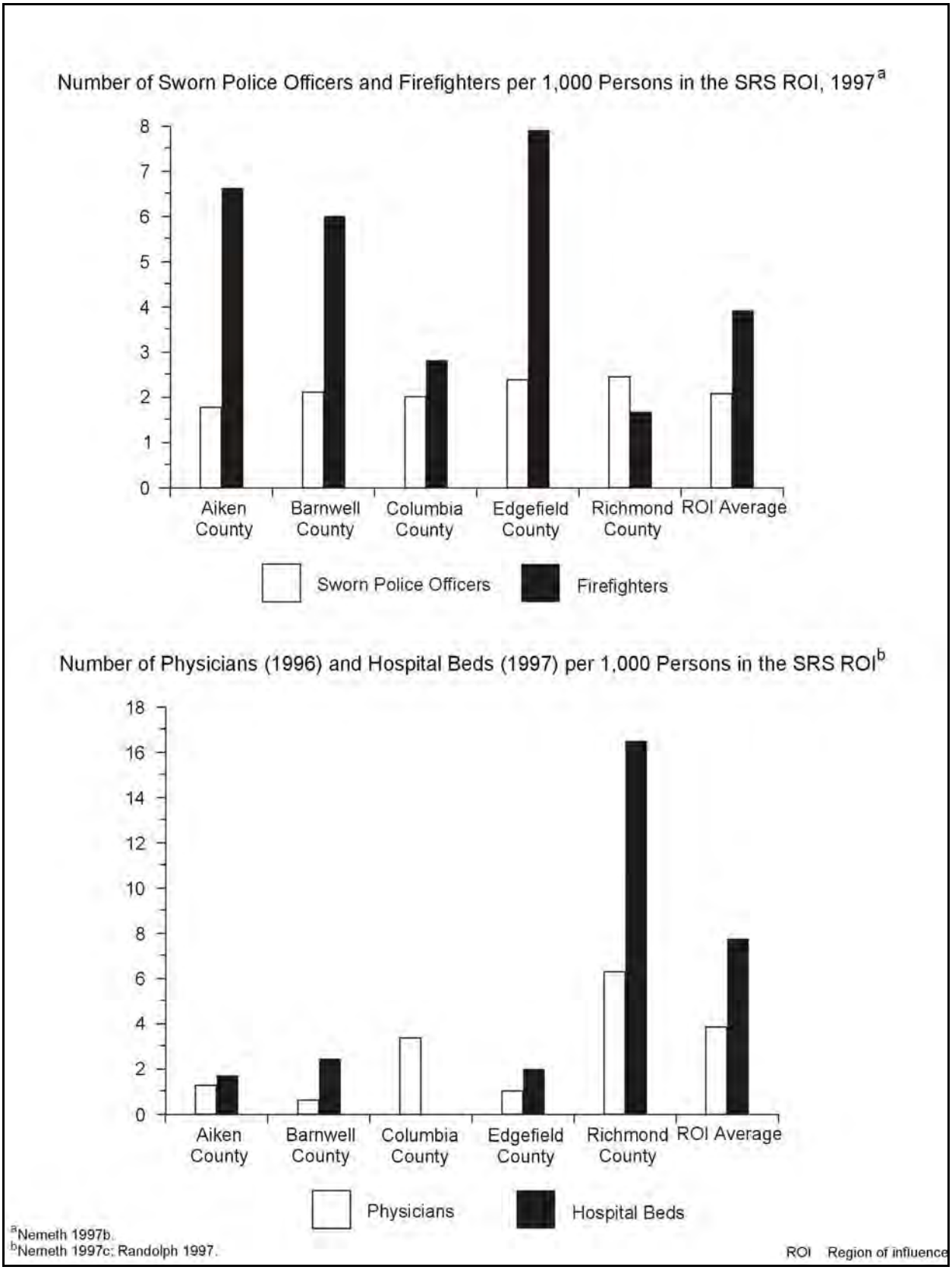


Figure 3–29. Public Safety and Health Care Characteristics for the SRS Region of Influence

3.5.3.4 Local Transportation

Vehicular access to SRS is provided by South Carolina State Routes 19, 64, and 125 (see Figure 2–5). Two road segments in the ROI could be affected by the disposition alternatives: South Carolina State Route 19 from U.S. I–78 at Aiken to U.S. 278 and South Carolina State Route 230 from U.S. 25 Business at North Augusta to U.S. I–25, I–78, and I–278. Three road improvement projects are planned that would alleviate traffic congestion leading into SRS.

The first improvement project is the widening of South Carolina State Route 302, Pine Log Road, from U.S. Route 78 and the construction of new segments to extend the route to South Carolina State Route 19. U.S. Route 25 is also being widened for one-half mile south of I–20. The widening project will be in conjunction with the second improvement project, the new construction of the Bobby Jones Expressway. The expressway will head in a southwest direction crossing South Carolina State Routes 126 and 125 and U.S. Route 1 and continue over the Savannah River to connect with the Georgia portion of the Bobby Jones Expressway, which is already constructed. The third improvement project is the completion of the South Carolina State Route 118 around Aiken. South Carolina State Route 118 will be widened with the construction of new segments to complete the by-pass (Sullivan 1997).

There is no public transportation to SRS. 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.

Waterborne transportation is available via the Savannah River. Currently, the Savannah River is used primarily for recreation. SRS has no commercial docking facilities, but it has a boat ramp that has accepted large transport barge shipments.

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 (DOE 1996a).

3.5.4 Existing Human Health Risk

Public and occupational health and safety issues include the determination of potentially adverse effects on human health that result from acute and chronic exposures to ionizing radiation and hazardous chemicals.

3.5.4.1 Radiation Exposure and Risk

3.5.4.1.1 General Site Description

Major sources and levels of background radiation exposure to individuals in the vicinity of SRS are shown in Table 3–44. Annual background radiation doses to individuals are expected to remain constant over time. The total dose to the population, in terms of person-rem, changes as the population size changes. Background radiation doses are unrelated to SRS operations.

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 1996 are listed in the *Savannah River Site Environmental Report for 1996* (Arnett and Mamatey 1997a:71–73). Doses to the public resulting from these releases are presented in Table 3–45. These doses fall within radiological limits per DOE Order 5400.5 (DOE 1993a:II-1–II-5) and are much lower than those of background radiation.

Table 3–44. Sources of Radiation Exposure to Individuals in the SRS Vicinity Unrelated to SRS Operations

Source	Effective Dose Equivalent (mrem/yr)
Natural background radiation[a]	
Cosmic radiation	27
External radiation	28
Internal terrestrial radiation	40
Radon in homes (inhaled)	200[b]
Other background radiation[c]	
Diagnostic x rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	360

[a] Arnett and Mamatey 1997a:116.
[b] An average for the United States.
[c] NCRP 1987:11, 40, 53.

Table 3–45. Radiation Doses to the Public From Normal SRS Operations in 1996 (Total Effective Dose Equivalent)

	Atmospheric Releases		Liquid Releases		Total	
Members of the Public	**Standard**[a]	**Actual**	**Standard**[a]	**Actual**[b]	**Standard**[a]	**Actual**
Maximally exposed individual (mrem)	10	0.06	4	0.14	100	0.20
Population within 80 km (person-rem)[c]	None	6.4	None	2.2	100	8.6
Average individual within 80 km (mrem)[d]	None	1.0×10^{-2}	None	3.2×10^{-3}	None	1.4×10^{-2}

[a] The standards for individuals are given in DOE Order 5400.5 (DOE 1993a:II-1–II-5). As discussed in that order, the 10-mrem/yr limit from airborne emissions is required by the Clean Air Act, and the 4-mrem/yr limit is required by the Safe Drinking Water Act; for this SPD EIS the 4-mrem/yr value is conservatively assumed to be the limit for the sum of doses from all liquid pathways. 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, as published in 58 FR 16268 (DOE 1993b:para. 834.7). If the potential total dose exceeds the 100-person-rem value, it is required that the contractor operating the facility notify DOE.
[b] 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] About 620,100 in 1996. For liquid releases, an additional 70,000 water users in Port Wentworth, Georgia, and Beaufort, South Carolina (about 160 km [98 mi] downstream), are included in the assessment.
[d] Obtained by dividing the population dose by the number of people living within 80 km (50 mi) of the site for atmospheric releases; for liquid releases the number of people includes water users who live more than 80 km (50 mi) downstream of the site.

Source: Arnett and Mamatey 1997a:108, 111, 112, 115.

Using a risk estimator of 500 cancer deaths per 1 million person-rem (5×10^{-4} fatal cancer per person-rem) to the public (see Appendix F.10), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from SRS operations in 1996 is estimated to be 1.0×10^{-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 1 in 10 million. (It takes several to many years from the time of radiation exposure for a cancer to manifest itself.)

According to the same risk estimator, 0.0043 excess fatal cancer is projected in the population living within 80 km (50 mi) of SRS from normal operations in 1996. To place this number in perspective, it may be compared with the number of fatal cancers expected in the same population from all causes. The 1996 mortality rate

associated with cancer for the entire U.S. population was 0.2 percent per year (Famighetti 1998:964). Based on this national mortality rate, the number of fatal cancers from all causes expected during 1996 in the population living within 80 km (50 mi) of SRS was 1,240. This expected number of fatal cancers is much higher than the 0.0043 fatal cancers estimated from SRS operations in 1996.

SRS workers receive the same dose as the general public from background radiation, but also receive an additional dose from working in facilities with nuclear materials. Table 3–46 presents the average worker and cumulative worker dose to SRS workers from operations in 1996. These doses fall within the radiological regulatory limits of 10 CFR 835 (DOE 1995b:paragraph 835.202). According to a risk estimator of 400 fatal cancers per 1 million person-rem among workers[8] (Appendix F.10), the number of projected fatal cancers to SRS workers from normal operations in 1996 is 0.095.

Table 3–46. Radiation Doses to Workers From Normal SRS Operations in 1996 (Total Effective Dose Equivalent)

	Onsite Releases and Direct Radiation	
Occupational Personnel	**Standard[a]**	**Actual**
Average radiation worker (mrem)	None[b]	19.0
Total workers (person-rem)[c]	None	237

[a] The radiological limit for an individual worker is 5,000 mrem/yr (DOE 1995a:para. 835.202). However, DOE's goal is to maintain radiological exposure as low as reasonably achievable. It has therefore established an administrative control level of 2,000 mrem/yr (DOE 1994a:2-3); DOE must make reasonable attempts to maintain worker doses below this level.

[b] No standard is specified for an "average radiation worker"; however, the maximum dose that this worker may receive is limited to that given in footnote "a."

[c] About 12,500 (badged) in 1996.

Source: Sessions 1997c.

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 1996* (Arnett and Mamatey 1997a). The concentrations of radioactivity in various environmental media (including air, water, and soil) in the site region (on and off the site) are also presented in that report.

3.5.4.1.2 Proposed Facility Locations

External radiation doses and concentrations of gross alpha, plutonium, and americium in air have been measured in F- and S-Areas. In 1996, the annual doses in the F- and S-Areas were 106 and 111 mrem, respectively. Both are higher than the dose of 87 mrem measured at the offsite control location. In the same year, the concentrations of gross alpha were about 1.3×10^{-3} pCi/m^3 and 9.8×10^{-4} pCi/m^3 in the F- and S-Areas, respectively, compared with the approximately 9.4×10^{-4} pCi/m^3 measured at the offsite control location. The concentrations of plutonium 239 in the F- and S-Areas were about 8.4×10^{-7} and 0 pCi/m^3, respectively. Offsite controls did not detect any plutonium 239 in the air in 1996 (Arnett and Mamatey 1997a:80; 1997b:31, 33, 40, 42).

[8] The risk estimator for workers is lower than the estimator for the public because of the absence from the workforce of the more radiosensitive infant and child age groups.

3.5.4.2 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 through which people may come in contact with hazardous chemicals (e.g., surface water during swimming, soil through direct contact, or food). Hazardous chemicals can cause cancer and noncancer health effects. The baseline data for assessing potential health impacts from the chemical environment are addressed in Section 3.5.1.

Effective administrative and design controls that decrease hazardous chemical releases to the environment and help achieve compliance with permit requirements (e.g., air emissions and NPDES permit requirements) contribute to minimizing health impacts on the public. The effectiveness of these controls is verified through the use of monitoring information and inspection of mitigation measures. Health impacts on the public may occur via inhalation of air containing hazardous chemicals released to the atmosphere during normal SRS operations. Risks to public health from other possible pathways, such as ingestion of contaminated drinking water or direct exposure, are lower than those via the inhalation pathway.

Baseline air emission concentrations and applicable standards for hazardous chemicals are addressed in Section 3.5.1. The baseline 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 on estimating the health impacts of hazardous chemicals is presented in Appendix F.10.

Exposure pathways to SRS workers during normal operations may include inhaling contaminants in the workplace atmosphere and direct contact with hazardous materials. The potential for health impacts varies among facilities and workers, and available information is insufficient for a detailed estimate of impacts. Workers are protected from workplace hazards through appropriate training, protective equipment, monitoring, substitution, and engineering and management controls. They 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 used in the operational processes ensures that these standards are not exceeded. Additionally, DOE requires that conditions in the workplace be as free as possible from recognized hazards that cause or are likely to cause illness or physical harm. Therefore, workplace conditions at SRS are substantially better than required by standards.

3.5.4.3 Health Effects Studies

One epidemiological study on the general population in communities surrounding SRS has been conducted and published. No evidence of excess cancer mortality, congenital anomalies, birth defects, early infancy deaths, strokes, or cardiovascular deaths was reported. The epidemiological literature on the facility reflects an excess of leukemia deaths among hourly workers; no other health effects for workers are reported. For a more detailed description of the studies reviewed and their findings, and for a discussion of the epidemiologic surveillance program implemented by DOE to monitor the health of current SRS workers, refer to Appendix M.4.7 of the *Storage and Disposition PEIS* (DOE 1996a:M-242, M-243).

3.5.4.4 Accident History

Between 1974 and 1988, there were 13 inadvertent tritium releases from the SRS tritium facilities. These releases were attributed to aging equipment in the tritium-processing facility and are one of the reasons for the construction of the Replacement Tritium Facility at SRS. A detailed description and study of these incidents and the consequences thereof for the offsite population have been documented by SRS. The most significant were

in 1981, 1984, and 1985, when, respectively, 32,934, 43,800, and 19,403 Ci of tritiated water vapor were released (DOE 1996a:3-259). From 1989 through 1992, there were 20 inadvertent releases, all with little or no offsite dose consequences. The largest of the recent releases occurred in 1992 when 12,000 Ci of tritium were released (Arnett, Karapatakis, and Mamatey 1993:260).

In 1993, an inadvertent release of 0.18 microcurie (mCi) of plutonium 238 and plutonium 239 took place. Westinghouse Savannah River Company emergency response models estimated an exposure of 0.0019 mrem to a hypothetical person at the site boundary (Arnett, Karapatakis, and Mamatey 1994:178).

3.5.4.5 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 to most accident conditions and to provide response efforts for accidents not specifically considered. The emergency management program includes 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. Emergency plans have been prepared for specific areas at SRS. Participating government agencies whose plans are interrelated with the SRS emergency plan for action include the States of South Carolina and Georgia, the City of Aiken, and the various counties in the general region of the site. Emergency response support, including firefighting and medical assistance, would be provided by these jurisdictions.

DOE has specified actions to be taken at all DOE sites to implement lessons learned from the emergency response to an accidental explosion at Hanford in May 1997. These actions and the timeframe in which they must be implemented are presented in Section 3.2.4.5.

3.5.5 Environmental Justice

Environmental justice concerns the environmental impacts that proposed actions may have on minority and low-income populations, and whether such impacts are disproportionate to those on the population as a whole in the potentially affected area. In the case of SRS, the potentially affected area includes parts of Georgia and South Carolina.

The potentially affected area around the location of the proposed surplus plutonium disposition facilities in F-Area is defined by a circle with an 80-km (50-mi) radius centered at the Actinide Packaging and Storage Facility
| (APSF), if built, (lat. 33E17'32" N, long. 81E40'26" W). The total population residing within that area in 1990
| was 614,095. The proportion of the population there that was considered minority was 38.0 percent.

Figure 3–30 illustrates the racial and ethnic composition of the minority population in the potentially affected area surrounding APSF, if built. At the time of the 1990 census, Blacks were the largest minority group within that area, constituting 35.7 percent of the total population. Hispanics constituted about 1.1 percent, and Asians, about 1 percent. Native Americans comprised about 0.2 percent of the population (DOC 1992).

| [Text deleted.]

The potentially affected area around S-Area is defined by a circle with an 80-km (50-mi) radius centered at DWPF (lat. 33E17'43" N, long. 81E38'25" W). The total population residing within that area in 1990 was
| 626,317. The proportion of the population around this facility that was considered minority was 38.5 percent.

Figure 3–30 illustrates the racial and ethnic composition of the minority population in the potentially affected area around the S-Area. At the time of the 1990 census, Blacks were the largest minority group within the potentially affected area, constituting 36.3 percent of the total population. Hispanics constituted about 1.0 percent, and Asians, about 1 percent. Native Americans constituted about 0.2 percent of the population (DOC 1992). The same census data show that the percentage of minorities for the contiguous United States was 24.1, and the percentages for the States of Georgia and South Carolina, 29.8 and 31.4, respectively (DOC 1992).

A breakdown of incomes in the potentially affected area is also available from the 1990 census data (DOC 1992). At that time, the poverty threshold was $9,981 for a family of three with one related child under 18 years of age. A total of 107,057 persons (18.0 percent of the total population) residing within the potentially affected area around F-Area at APSF, if built, reported incomes below the poverty threshold. [Text deleted.] The low-income population around S-Area at DWPF was 109,217 (18.0 percent of the total population).

Data obtained during the 1990 census also show that of the total population of the contiguous United States, 13.1 percent reported incomes below the poverty threshold, and that Georgia and South Carolina reported 14.7 and 15.4 percent, respectively.

3.5.6 Geology and Soils

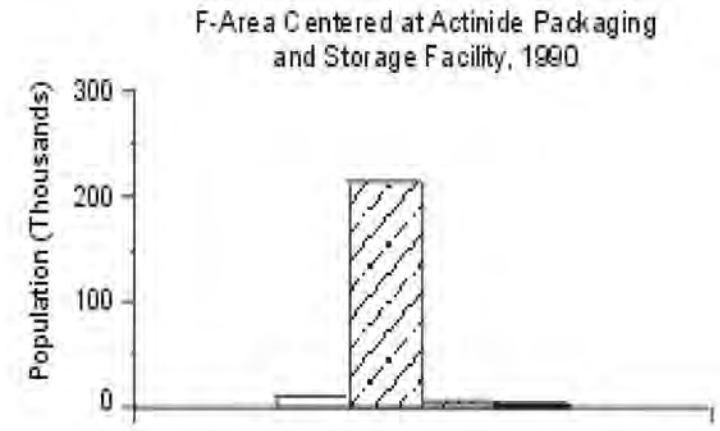
Geologic resources are consolidated or unconsolidated earth materials, including ore and aggregate materials, fossil fuels, and significant landforms. Soil resources are the loose surface materials of the earth in which plants grow, usually consisting of disintegrated rock, organic matter, and soluble salts.

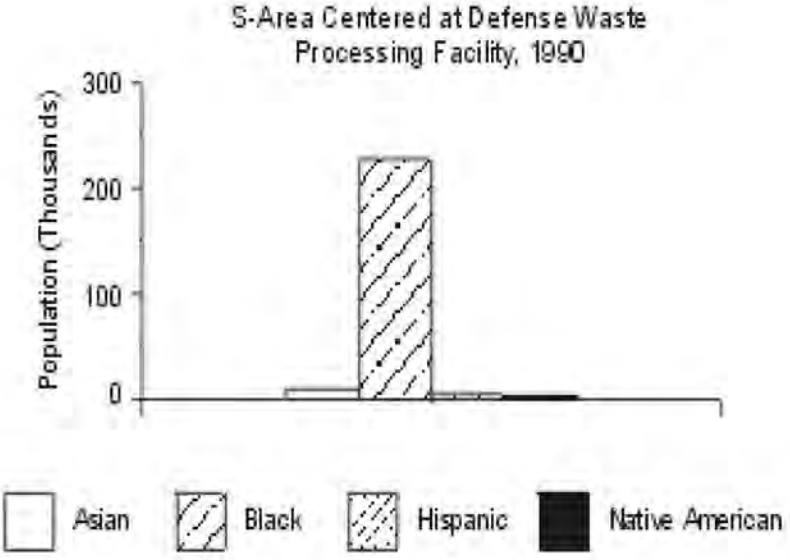
3.5.6.1 General Site Description

Coastal Plain sediments beneath SRS overlie a basement complex composed of Paleocene crystalline and Triassic sedimentary formations of the Dunbarton Basin. Small and discontinuous zones of calcareous sand (i.e., sand containing calcium carbonate [calcite]), potentially subject to dissolution by water, are beneath 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 (DOE 1996a:3-241).

In the immediate region of SRS, there are no known capable faults. A capable fault is one that has had movement at or near the ground surface at least once within the past 35,000 years or recurrent movement within the past 500,000 years. 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. There is no evidence of movement within the last 38 million years along this fault (DOE 1996a:3-241).

According to the Uniform Building Code, SRS is in Seismic Zone 2, meaning that moderate damage could occur as a result of an earthquake (DOE 1996a:3-241). Two earthquakes occurred during recent years inside the SRS boundary. On June 8, 1985, an earthquake with a local Richter scale magnitude of 2.6 and a focal depth of about 1 km (0.6 mi) occurred at SRS. Its epicenter was west of C- and K-Areas. The acceleration produced by the earthquake did not activate seismic monitoring instruments in the reactor areas. (These instruments have detection limits of 0.002g.) On August 5, 1988, another earthquake with a local Richter scale magnitude of 2.0 and a focal depth of about 2.7 km (1.7 mi) occurred at SRS. Its epicenter was northwest of K-Area. The seismic alarms in SRS facilities were not triggered. Existing information does not conclusively correlate the two earthquakes with any of the known faults on the site (DOE 1995c:3-7). Earthquakes capable of producing structural damage are not likely to occur in the vicinity of SRS (DOE 1996a:3-241).





Source: DOC 1992.

Figure 3–30. Racial and Ethnic Composition of Minorities Around 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 scale magnitude ranging from 6.5 to 7.5 (DOE 1996a:3-241). The SRS area experienced an estimated peak horizontal acceleration of 0.10g during this earthquake (DOE 1995c:3-6). An earthquake with a maximum horizontal acceleration of 0.19g is estimated to have an annual probability of occurrence of 1 in 5,000 at SRS (Barghusen and Feit 1995:2.13–16).

There are no volcanic hazards at SRS. The area has not experienced volcanic activity within the last 230 million years (DOE 1996a:3-241). Future volcanism is not expected because SRS is along the passive continental margin of North America (Barghusen and Feit 1995:2.13–16).

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. Soil units that meet the soil requirements for prime farmland soils exist on SRS. However, the 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. The soils at SRS are considered acceptable for standard construction techniques (DOE 1996a:3-230, 3-241). Detailed descriptions of the geology and the soil conditions at SRS are included in the *Storage and Disposition PEIS* (DOE 1996a:3-241) and the *Savannah River Site Waste Management Final EIS* (DOE 1995c:3-4–3-6).

3.5.6.2 Proposed Facility Locations

Soils in F-Area are predominantly of the Fuquay-Blanton-Dothan association, consisting of nearly level to sloping, well-drained soils. Other soils include the Troup-Pickney-Lucy association, consisting of nearly level soils formed along, and parallel to, the floodplains of streams (Barghusen and Feit 1995:2.13–16).

Several subsurface investigations conducted on SRS waste management areas encountered soft sediments classified as calcareous sands. These sands were encountered in borings in S-Area between 33 and 35 m (108 to 115 ft) below ground surface. Preliminary information indicates that these calcareous zones are not continuous over large areas, nor are they very thick. No settling as a result of dissolution of these zones has been identified (DOE 1995c:3-6). Soils in S-Area are predominantly the same as those in F-Area (Barghusen and Feit 1995:2.13–16).

3.5.7 Water Resources

3.5.7.1 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.

3.5.7.1.1 General Site Description

The largest river in the area of SRS is the Savannah River, which borders the site on the southwest. Six streams flow through SRS and discharge into the Savannah River: Upper Three Runs Creek, Beaver Dam Creek, Fourmile Branch, Pen Branch, Steel Creek, and Lower Three Runs Creek. Upper Three Runs Creek has two tributaries, Tims Branch and Tinker Creek; Pen Branch has one, Indian Grave Branch; and Steel Creek, one, Meyers Branch (DOE 1996a:3-236).

There are two manmade lakes at SRS: L-Lake, which discharges to Steel Creek, and Par Pond, which discharges to Lower Three Runs Creek. Also, about 299 Carolina bays—i.e., closed depressions capable of holding

water—occur throughout the site. While these bays receive no direct effluent discharges, they do receive storm-water runoff (DOE 1996a:3-236; WSRC 1997b:6-124).

Water has historically been withdrawn from the Savannah River for use mainly as cooling water; some, however, has been used for domestic purposes (DOE 1996a:3-236). SRS currently withdraws about 140 billion l/yr (37 billion gal/yr) from the river. Most of this water is returned to the river through discharges to various tributaries (DOE 1996a:3-236).

The average flow of the Savannah River is 283 m^3/s (10,000 ft^3/s). Three large upstream reservoirs, Hartwell, Richard B. Russell, and Strom Thurmond/Clarks Hill, regulate the flow in the Savannah River, thereby lessening the impacts of drought and flooding on users downstream (DOE 1995c:3-14).

Several communities in the area use the Savannah River as a source of domestic water. The nearest downstream water intake is the Beaufort-Jasper Water Authority in South Carolina, which withdraws about 0.23 m^3/s (8.1 ft^3/s) to service about 51,000 people. Treated effluent is discharged to the Savannah River from upstream communities and from treatment facilities at SRS. The average annual volume of flow discharged by the sewage treatment facilities at SRS is about 700 million l (185 million gal) (DOE 1996a:3-236; Barghusen and Feit 1995:2.13-18).

It is clear that the surplus plutonium disposition facilities would not be located within a 100-year floodplain, but there is no information concerning 500-year floodplains (DOE 1996a:3-236). No federally designated Wild and Scenic Rivers occur within the site (Barghusen and Feit 1995:2.13-2). A map showing the 100-year floodplain is presented as Figure 3–31 (Noah 1995:52).

The Savannah River is classified as a freshwater source that is suitable for primary and secondary contact recreation; drinking, after appropriate treatment; fishing; balanced indigenous aquatic community development and propagation; and industrial and agricultural uses. A comparison of Savannah River water quality upstream (river mile 160) and downstream (river mile 120) of SRS showed no significant differences for nonradiological parameters (Arnett and Mamatey 1996:73, 119, 120). A comparison of current and historical data shows that the coliform data are within normal fluctuations for river water in this area. For the different river locations, however, there has been an increase in the number of analyses in which standards were not met. The data for the river's monitoring locations generally met the freshwater standards set by the State; a comparison of the 1995 and earlier measurements for river samples showed no abnormal deviations. As for radiological constituents, tritium is the predominant radionuclide detected above background levels in the Savannah River (Arnett and Mamatey 1996:80, 120).

Surface water rights for SRS are determined by the Doctrine of Riparian Rights, which allows owners of land adjacent to or under the water to use the water beneficially (DOE 1996a:3-239). SRS has five NPDES permits, two (SC0000175 and SC0044903) for industrial wastewater discharges, two (SCR000000 and SCR100000) for general storm-water discharges, and one (ND0072125) for land application. Permit SC0000175 regulates 76 outfalls; permit SC0044903, another 7. The 1995 compliance rate for these outfalls was 99.8 percent. The 48 storm-water–only outfalls regulated by the storm-water permits are monitored as required. A pollution prevention plan has been developed to identify where best available technology and best management practices must be used. For storm-water runoff from construction activities extending over 2 ha (5 acres), a sediment reduction and erosion plan is required (Arnett and Mamatey 1996:24, 114, 115, 226).

3.5.7.1.2 Proposed Facility Locations

The land around F-Area drains to Upper Three Runs Creek and Fourmile Branch (DOE 1995c:3-17). Upper Three Runs Creek is a large, cool blackwater stream that flows into the Savannah River. It drains about

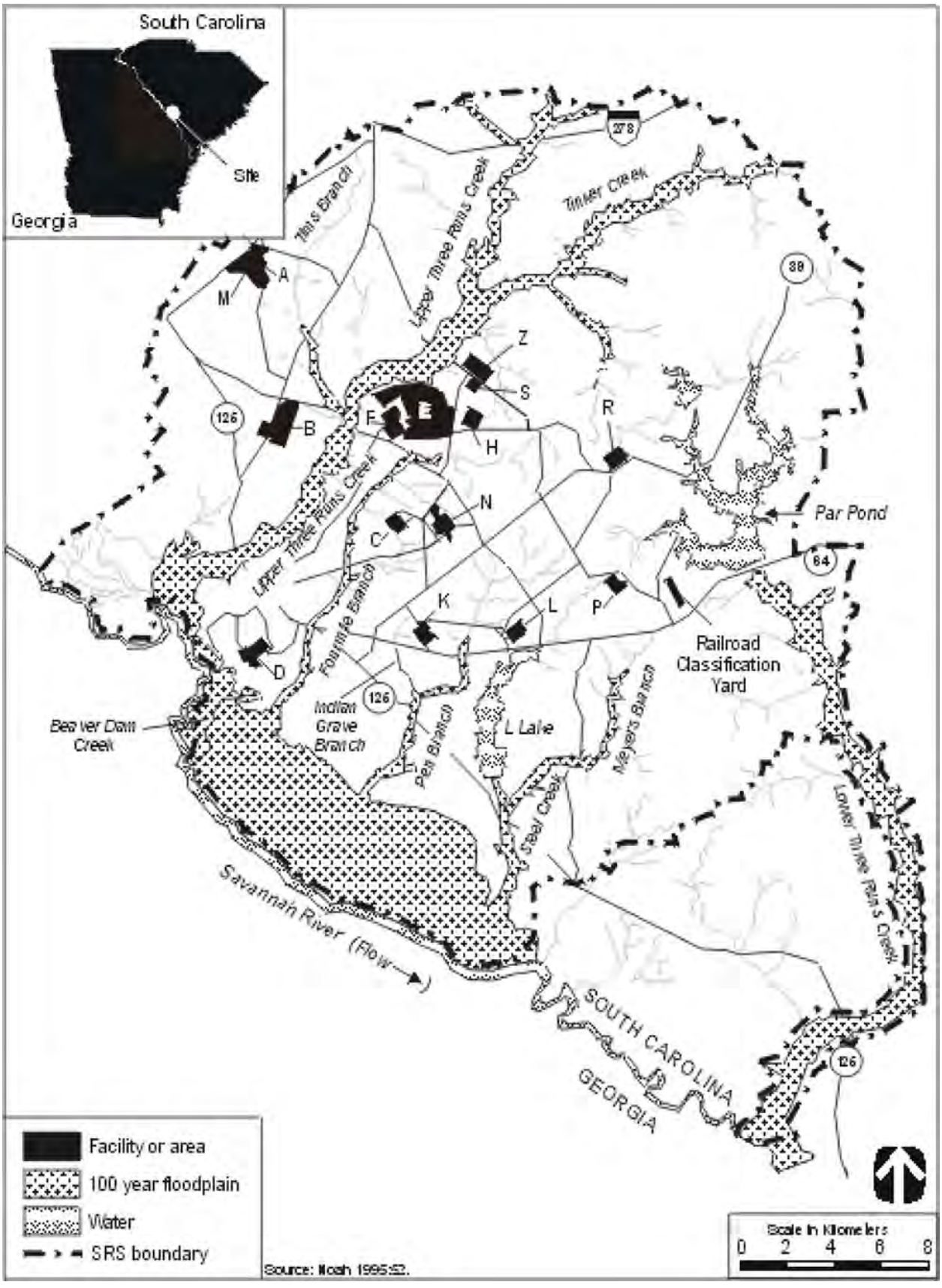


Figure 3–31. Locations of Floodplains at SRS

544 km^2 (210 mi^2), and during water year 1991, had a mean discharge of 6.8 m^3/s (240 ft^3/s) near its mouth. The 7-day, 10-year low flow, which is the lowest flow over any 7 days within any 10-year period, is about 2.8 m^3/s (100 ft^3/s). The stream is about 40 km (25 mi) long and only its lower reaches extend through SRS. It receives more water from underground sources than any other SRS stream, and therefore has lower dissolved solids, hardness, and pH values. It is the only major stream on the site that has not received thermal discharges. It receives permitted discharges from several areas at SRS, including F-Area, S-Area, S-Area sewage treatment plant, and treated industrial wastewater from the Chemical Waste Treatment Facility steam condensate. Flow from the sanitary wastewater discharge averages less than 0.001 m^3/s (0.035 ft^3/s or 16 gal/min). A comparison with the 7-day, 10-year low flow of 2.8 m^3/s (100 ft^3/s) in Upper Three Runs Creek shows that the present discharges are very small. The analytical results for the active outfalls show the constituents of concern are maintained within permit limitations (DOE 1994c:3-12–3-15; 1995c:3-15, 3-19).

Fourmile Branch is a blackwater stream affected by past operational practices at SRS. Its headwaters are near the center of the site, and it flows southwesterly before discharging into the Savannah River. The watershed is about 54 km^2 (21 mi^2) and receives permitted effluent discharges from F-Area and H-Area. This stream received cooling water discharges from C-Reactor while it was operating. Since those discharges ceased in 1985, the maximum recorded temperature in the stream has been 32 EC (90 EF), as opposed to ambient water temperatures that exceeded 60 EC (140 EF) when the reactor was operating. The average flow in the stream during C-Reactor operation was about 11.3 m^3/s (400 ft^3/s); since then flows have averaged about 1.8 m^3/s (64 ft^3/s) (DOE 1995c:3-19). In its lower reaches, this stream widens and flows via braided channels through a delta. Downstream of this delta area, it re-forms into one main channel, and most of the flow discharges into the Savannah River at river mile 152.1. When the Savannah River floods, water from Fourmile Branch flows along the northern boundary of the floodplain and joins with other site streams to exit the swamp via Steel Creek instead of flowing directly into the Savannah River (DOE 1995c:3-19).

The land surrounding S-Area also drains to Upper Three Runs Creek and Fourmile Branch. (Except for the differences noted in this section, stream information for F-Area is also relevant to S-Area.) Storm-water runoff from most of the area near DWPF is collected and discharged into a retention basin north of S-Area. Effluent from this basin is discharged at Outfall DW-005 to Crouch Branch, then to Upper Three Runs Creek (Arnett and Mamatey 1996:167; DOE 1994c:3-15). Analyses of samples from this outfall show a minimal impact of storm water on the water quality of Upper Three Runs Creek. Construction of DWPF adversely affected the water quality of Crouch Branch and McQueen Branch; however, enhanced erosion and sedimentation controls have been instituted at DWPF and in Z-Area. Also, startup of DWPF and the concurrent reduction in construction activities have assisted in reducing sediment loads to these streams (DOE 1994c:3-15).

3.5.7.2 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.

3.5.7.2.1 General Site Description

Although many different systems have been used to describe groundwater systems at SRS, for this SPD EIS the same system used in the *Storage and Disposition PEIS* has been adopted. The uppermost aquifer is referred to as the water table aquifer. It is supported by the leaky "Green Clay" aquitard, which confines the Congaree aquifer. Below the Congaree aquifer is the leaky Ellenton aquitard, which confines the Cretaceous aquifer, also known as the Tuscaloosa aquifer. In general, groundwater in the water table aquifer flows downward to the Congaree aquifer or discharges to nearby streams. Flow in the Congaree aquifer is downward to the Cretaceous

aquifer or horizontal to stream discharge or the Savannah River, depending on the location within SRS (DOE 1996a:3-239).

Groundwater in the area is used extensively for domestic and industrial purposes. Most municipal and industrial water supplies are withdrawn from the Cretaceous or water table aquifer, while small domestic supplies are withdrawn from the Congaree or water table aquifer. It is estimated that about 13 billion l/yr (3.4 billion gal/yr) are withdrawn from the aquifers within a 16-km (10-mi) radius of the site, which is similar to the volume used by SRS (DOE 1996a:3-239). The Cretaceous aquifer is an important water resource for the SRS region. The water is generally soft, slightly acidic, and low in dissolved and suspended solids (DOE 1995c:3-11, 3-13). Aiken, South Carolina, for example, uses the Cretaceous aquifer for drinking water.
Groundwater is the only source of domestic water at SRS (DOE 1995c:3-13). All groundwater at SRS is classified by EPA as a Class II water source, and depth to groundwater ranges from near the surface to about 46 m (150 ft). In 1993, SRS withdrew about 13 billion l/yr (3.4 billion gal/yr) of groundwater to support site operations (DOE 1996a:3-239). There are no designated sole source aquifers in the area (Barghusen and Feit 1995:2.13-2).

Groundwater ranges in quality across the site: in some areas it meets drinking water quality standards, while in areas near some waste sites it does not. The Cretaceous aquifer is generally unaffected except for an area near A-Area, where TCE has been reported. TCE has also been reported in the A- and M-Areas in the Congaree aquifer. Tritium has been reported in the Congaree aquifer in the Separations Area. The water table aquifer is contaminated with solvents, metals, and low levels of radionuclides at several SRS sites and facilities. Groundwater eventually discharges into onsite streams or the Savannah River (DOE 1996a:3-239), but groundwater contamination has not been detected beyond SRS boundaries (DOE 1995c:3-13).

Groundwater rights in South Carolina are associated with the absolute ownership rule. Owners of land overlying a groundwater source are allowed to withdraw as much water as they desire; however, the State requires users who withdraw more than 379,000 l/day (100,000 gal/day) to report their withdrawals. SRS is required to report because its usage is above the reporting level (DOE 1996a:3-239).

3.5.7.2.2 Proposed Facility Locations

Groundwater in the shallow, intermediate, and deep aquifers flows in different directions, depending on the depths of the streams that cut the aquifers. The shallow aquifer discharges to Upper Three Runs Creek and Fourmile Branch. Shallow groundwater in the vicinity of S-Area flows toward Upper Three Runs Creek, McQueen Branch, or Fourmile Branch. Groundwater in the intermediate and deep aquifers flows horizontally toward the Savannah River and southeast toward the coast (DOE 1994c:3-4, 3-6).

Groundwater also moves vertically. In the shallow aquifer, it moves downward until its movement is obstructed by impermeable material. Operating under a different set of physical conditions, groundwater in the intermediate and deep aquifers flows mostly horizontally. Near F-Area it moves upward due to higher water pressure below the confining unit between the upper and lower aquifers. This upward movement helps to protect the lower aquifers from contaminants found in the shallow aquifer. The depth to groundwater in F-Area varies from about 1 to 20 m (3.3 to 66 ft) (DOE 1994c:3-6).

Groundwater quality in F-Area is not significantly different from that for the site as a whole. It is abundant, usually soft, slightly acidic, and low in dissolved solids. High dissolved iron concentrations occur in some aquifers. Where needed, groundwater is treated to raise the pH and remove iron. Results of sampling in the shallow aquifer have indicated excursions from drinking water standards for lead, tetrachloroethylene, and tritium in S-Area wells (DOE 1994c:3-6, 3-9).

F-Area groundwater quality can exceed drinking water standards for several contaminants. Near the F-Area seepage basins and inactive process sewer line, radionuclide contamination is widespread. Most of these wells contain tritium above drinking water standards. Other wells exhibit gross alpha, gross beta, strontium 90, and iodine 129 above their standards. Other radionuclides found above proposed standards in several wells include americium 241; curium 243 and 244; radium 226 and 228; strontium 90; total alpha–emitting radium; and uranium 233, 234, 235, and 238. Cesium 137, curium 245 and 246, and plutonium 238 were also found (Arnett and Mamatey 1996:143, 144).

Near the F-Area Tank Farm, tritium, mercury, nitrate-nitrite as nitrogen, cadmium, gross alpha, and lead were detected above drinking water standards in one or more wells. The pH exceeded the basic standard, and trichlorofluoromethane (Freon 11), which has no drinking water standard, was present in elevated levels (Arnett and Mamatey 1996:153).

At the F-Area Sanitary Sludge Land Application Site, tritium, specific conductance, lead, and copper were found to exceed their drinking water standards in one or more wells (Arnett and Mamatey 1996:154). Groundwater near the F-Area Acid/Caustic Basin consistently exceeded drinking water standards for gross alpha. Total alpha-emitting radium, alkalinity, gross beta, nitrate as nitrogen, and pH were above their respective standards in one or more wells (Arnett and Mamatey 1996:138). The groundwater near the F-Area Coal Pile Runoff Containment Basin did not exceed any chemical or radiological standard during 1995 (Arnett and Mamatey 1996:141).

Groundwater flow and conditions in S-Area are not significantly different from those in F-Area. Tritium, tetrachloroethylene, and TCE exceeded the drinking water standards near the S-Area facilities. The groundwater in one well near the S-Area Low-Point Pump Pit also contained tritium in excess of drinking water standards. No other radiological or chemical constituents have been detected above standards since 1989 (Arnett and Mamatey 1996:149). Near the S-Area vitrification building, also known as the S-Area Canyon, tritium exceeded drinking water standards, and specific conductance and alkalinity were elevated (Arnett and Mamatey 1996:149).

3.5.8 Ecological Resources

Ecological resources are defined as terrestrial (predominantly land) and aquatic (predominantly water) ecosystems characterized by the presence of native and naturalized plants and animals. For the purposes of this SPD EIS, those ecosystems are differentiated in terms of habitat support of threatened, endangered, and other special-status species—that is, "nonsensitive" versus "sensitive" habitat.

3.5.8.1 Nonsensitive Habitat

Nonsensitive habitat comprises those terrestrial and aquatic areas of the site that typically support the region's major plant and animal species.

3.5.8.1.1 General Site Description

At least 90 percent of the SRS land cover is composed of upland pine and bottomland hardwood forests (DOE 1997a:4-97). Five major plant communities have been identified at SRS: bottomland hardwood (most commonly sweetgum and yellow poplar); upland hardwood-scrub oak (predominantly oaks and hickories); pine/hardwood; loblolly, longleaf, and slash pine; and swamp. The loblolly, longleaf, and slash pine community covers about 65 percent of the upland areas of the site. Swamp forests and bottomland hardwood forests occur along the Savannah River and the numerous streams found on the site (Figure 3–32) (DOE 1995a:vol. 1, app. C, 4-47; 1996a:3-242).

The biodiversity of the region is extensive due to the variety of plant communities and the mild climate. Animal species known to inhabit SRS include 44 species of amphibians, 255 species of birds, 54 species of mammals, and 59 species of reptiles. Common species include the eastern box turtle, Carolina chickadee, common crow, eastern cottontail, and gray fox (DOE 1996a:3-242; WSRC 1997b:3-3). Game animals include a number of species, two of which, the white-tailed deer and feral hogs, are hunted on the site (DOE 1996d:3-56). Raptors, such as the Cooper's hawk and black vulture, and carnivores, such as the gray fox are ecologically important groups at SRS (DOE 1996a:3-242).

Aquatic habitat includes manmade ponds, Carolina bays, reservoirs, and the Savannah River and its tributaries. There are more than 50 manmade impoundments throughout the site that support populations of bass and sunfish. Carolina bays, a type of wetland unique to the southeastern United States, are natural shallow depressions that occur in interstream areas. These bays can range from lakes to shallow marshes, herbaceous bogs, shrub bogs, or swamp forests. Among the 299 Carolina bays found throughout SRS, fewer than 20 have permanent fish populations. Redfin pickerel, mud sunfish, lake chubsucker, and mosquito fish are present in these bays. Although sport and commercial fishing is not permitted at SRS, the Savannah River is used extensively for both. Important commercial species are the American shad, hickory shad, and striped bass, all of which are anadromous. The most important warm-water game fish are bass, pickerel, crappie, bream, and catfish (DOE 1996a:3-244; WSRC 1997b:6-124).

3.5.8.1.2 Proposed Facility Locations

F-Area and S-Area are situated on an upland plateau between the drainage areas of Upper Three Runs Creek and Fourmile Branch. These heavily industrialized areas are dominated by buildings, paved parking lots, graveled construction areas, and laydown yards; little natural vegetation remains inside the fenced areas. Grassed areas occur around the administration buildings, and some vegetation is present along drainage ditches, but most of the developed areas have no vegetation (DOE 1994c:3-24; 1995b:vol. 1, app. C, 4-47). The most common plant communities in the vicinities of F-Area and S-Area include loblolly, longleaf, and slash pine; upland hardwood-scrub oak; pine/hardwood; and bottomland hardwood (DOE 1995c:3-34, 3-35; DOE 1996a:3-242). Cleared fields are also common in F-Area, and a roughly 6-ha (15-acre) oak-hickory forest area designated as a National Environmental Research Park set aside is northwest of F-Area (DOE 1996a:3-242).

A recent (1994–1997) study was conducted to document the composition and diversity of urban wildlife, those species of amphibians, birds, mammals and reptiles that inhabit or temporarily use the developed areas on SRS. Results indicate that the use of the developed areas by wildlife species is more common than has been previously reported (Mayer and Wike 1997:8, 52). A total of 41 wildlife species were observed in and around F-Area, including 18 species of birds, 11 species of mammals, and 12 species of reptiles. Similarly, S-Area produced sightings of 36 wildlife species, including 19 species of birds, 9 species of mammals, and 8 species of reptiles. Bird species commonly seen include the bufflehead (F-Area only), turkey vulture, black vulture, killdeer, rock dove, mourning dove, chimney swift (F-Area only), great crested flycatcher (F-Area only), barn swallow, common crow, fish crow, northern mockingbird, American robin, loggerhead shrike (S-Area only), European starling, house sparrow (S-Area only), red-winged blackbird (S-Area only), and common grackle. Frequently sighted mammals include the Virginia opossum, eastern cottontail (F-Area only), house mouse, feral cat, striped skunk, and raccoon. The only reptile commonly observed is the banded water snake (Mayer and Wike 1997:9–14).

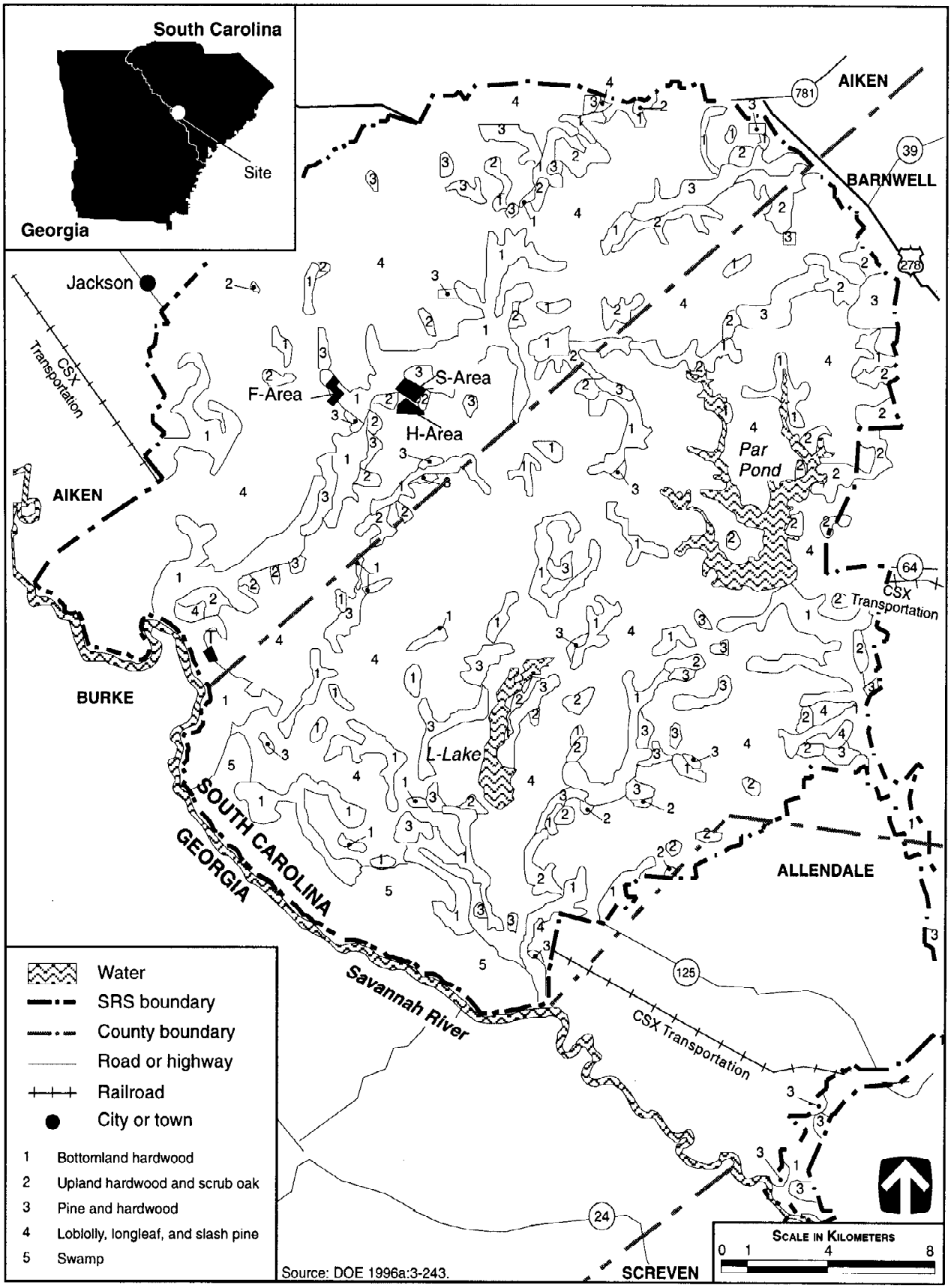


Figure 3–32. Major Plant Communities at SRS

Upper Three Runs Creek and its tributaries and three Carolina bays constitute the aquatic habitat in the vicinity of F-Area and S-Area. Streams support largemouth bass, black crappie, and various species of pan fish. Upper Three Runs Creek has a rich fauna; more than 551 species of aquatic insects have been collected (DOE 1996a:3-244; WSRC 1997b:5-32). It is important as a spawning area for blueback herring, and as a seasonal nursery habitat for American shad, striped bass, and other Savannah River species. Aquatic resources information on the three Carolina bays is unavailable (DOE 1996a:3-244).

3.5.8.2 Sensitive Habitat

Sensitive habitat comprises those terrestrial and aquatic (including wetlands) areas of the site that support threatened and endangered, State-protected, and other special-status plant and animal species.[9]

3.5.8.2.1 General Site Description

SRS wetlands, most of which are associated with floodplains, streams, and impoundments, include bottomland hardwood, cypress-tupelo, scrub-shrub, and emergent vegetation, as well as open water. Swamp forest along the Savannah River is the most extensive wetlands vegetation type (DOE 1996a:3-242).

Sixty-one threatened, endangered, and other special-status species listed by the Federal Government or the State of South Carolina may be found in the vicinity of SRS, as shown in Table 3.7.6–1 in the *Storage and Disposition PEIS*. No critical habitat for threatened or endangered species exists on SRS (DOE 1996a:3-245).

3.5.8.2.2 Proposed Facility Locations

No federally listed threatened or endangered species are known to occur in F-Area or S-Area, but several species that may exist in the general vicinity of these areas are listed in Table 3–47. The American alligator, although listed as threatened (by virtue of similarity in appearance to the endangered crocodile) is fairly abundant on SRS. It was recently observed near F-Area, but its occurrence there is seen as uncommon. Furthermore, no State-listed protected species have been found in any developed area on SRS, and of the State-listed organisms known to occur, none would be expected to use any of the disturbed areas for extended periods (Mayer and Wike 1997:42).

The Pen Branch area, about 14 km (8.7 mi) southwest of the proposed sites, and an area south of Par Pond, about 12 km (7.5 mi) to the southeast, support active bald eagle nests. Wood storks have been observed about 21 km (13 mi) from the proposed site, near the Fourmile Branch delta. The closest colony of red-cockaded woodpeckers is about 5 km (3.1 mi) away, but suitable forage habitat exists on the proposed sites. The smooth purple coneflower, the only endangered plant species found on SRS, could be found on the proposed sites (DOE 1996a:3-245). Botanical surveys conducted by the Savannah River Forest Station in 1992 and 1994 identified three populations of Oconee azalea in the area northwest of F-Area. This State-listed rare plant species, was found on the steep slopes adjacent to the Upper Three Runs Creek floodplain (DOE 1995c:3-37).

3.5.9 Cultural and Paleontological Resources

Cultural resources are human imprints on the landscape and are defined and protected by a series of Federal laws, regulations, and guidelines. Field studies conducted over the past two decades by the South Carolina Institute of Archaeology and Anthropology of the University of South Carolina have provided considerable information about the distribution and content of cultural resources at SRS. About 60 percent of SRS has been surveyed, and 858 archaeological (historic and prehistoric) sites have been identified (DOE 1995c). There are 67 sites considered potentially eligible for listing on the National Register; most of the sites have not yet been

[9] The Federal Government defines threatened and endangered species in the Endangered Species Act, and wetlands in 33 CFR 328.3.

Table 3–47. Threatened and Endangered Species, Species of Concern, and Sensitive Species Occurring or Potentially Occurring in the Vicinity of F-Area and S-Area

Common Name	Scientific Name	Federal Status	State Status
Birds			
Bald eagle	*Haliaeetus leucocephalus*	Threatened	Endangered
Red-cockaded woodpecker	*Picoides borealis*	Endangered	Endangered
Wood stork	*Mycteria americana*	Endangered	Endangered
Plants			
Oconee azalea	*Rhododendron flammeum*	Not listed	Species of Concern
Smooth purple coneflower	*Echinacea laevigata*	Endangered	Endangered
Reptiles			
American alligator	*Alligator mississippiensis*	Threatened (S/A)[a]	Not listed

[a] Protected under the Similarity of Appearance Provision of the Endangered Species Act.

Source: DOE 1996a:3-245–3-248; EuDaly 1998; Mayer and Wike 1997:9–14, 42.

evaluated (DOE 1996a:3-249). No SRS nuclear production facilities have been nominated for the National Register, and there are no plans for nominations. Existing SRS facilities lack architectural integrity and do not contribute to the broad historic theme of the Manhattan Project and the production of World War II era nuclear materials (DOE 1995c:vol. I, 3-53, 3-54).

Cultural sites are often occupied continuously or intermittently over substantial time spans. For this reason, a single location (sites) may contain evidence of use during both historic and prehistoric periods. In the discussions that follow, the numbers of prehistoric and historic resources are presented; the sum of these resources may be greater than the total number of sites reported due to this dual-use history at sites. Therefore, where the total number of sites reported is less than the sum of prehistoric and historic sites certain locations were used during both periods.

Cultural resources at SRS are managed under the terms of a programmatic memorandum of agreement among the DOE Savannah River Operations Office, the South Carolina State Historic Preservation Officer, and the Advisory Council on Historic Preservation, dated August 24, 1990 (WSRC 1997b:sec. 2.6). Guidance on the management of cultural resources at SRS is included in the *Archaeological Resources Management Plan of the Savannah River Archaeological Research Program* (SRARP 1989).

3.5.9.1 Prehistoric Resources

Prehistoric resources are physical properties that remain from human activities that predate written records.

3.5.9.1.1 General Site Description

Prehistoric resources at SRS consist of villages, base camps, limited-activity sites, quarries, and workshops. An extensive archaeological survey program begun at SRS in 1974 includes numerous field studies such as reconnaissance surveys, shovel test transects, and intensive site testing and excavation. There is prehistoric evidence of more than 800 sites, some of which may fall in the vicinity of the proposed facilities. Fewer than 8 percent of these sites have been evaluated for National Register eligibility (DOE 1996a:3-249).

3.5.9.1.2 Proposed Facility Locations

Within F-Area, land areas have been disturbed over the past 46 years by activities associated with construction and operation of the extant facilities. Although no archaeological surveys have been conducted within the

boundary of F-Area, no prehistoric cultural materials have been, or are expected to be, identified within this industrial area.

The proposed construction area adjacent to F-Area has been surveyed for prehistoric and historic archaeological resources. A number of archaeological sites within this area contain prehistoric materials considered potentially eligible for nomination to the National Register (Cabak, Sassaman, and Gillam 1996:199–312; SRARP 1997; Stephenson and King 1999). Prior to any activity with potential impact on the sites in this area, a consultation process would be initiated with the South Carolina State Historic Preservation Officer to formally determine the eligibility of specific sites and to determine necessary and appropriate mitigation measures.

A survey of S-Area prior to construction of DWPF revealed no archaeological resources potentially eligible for nomination to the National Register.

3.5.9.2 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.

3.5.9.2.1 General Site Description

Types of historic sites include farmsteads, tenant dwellings, mills, plantations and slave quarters, rice farm dikes, dams, cattle pens, ferry locations, towns, churches, schools, cemeteries, commercial building locations, and roads. About 400 historic sites or sites with historic components have been identified within SRS, and some of these may fall within the locations of the proposed facilities. To date, about 10 percent of the historic sites have been evaluated for National Register eligibility. Most pre-SRS era historic structures were demolished during the initial establishment of SRS in 1950. Two SRS era buildings built in 1951 remain in use. From a Cold War perspective, SRS has been involved in tritium operations and other nuclear material production for more than 40 years; therefore, some existing facilities and engineering records may have significant historical and scientific content (DOE 1996a:3-249).

3.5.9.2.2 Proposed Facility Locations

Within F-Area, land areas have been disturbed over the past 46 years by activities associated with the construction and operation of the extant facilities. Although no surveys have been conducted within the boundary of F-Area, no historic resources are expected to be identified with the possible exception of surviving facilities and engineering records from the Cold War era (DOE 1996a:3-249).

The proposed construction area adjacent to and northeast of F-Area has been surveyed for prehistoric and historic archaeological resources. Four known archaeological resources containing historic materials are considered potentially eligible for nomination to the National Register (Cabak, Sassaman, and Gillam 1996:199–312). Prior to any activity with potential impact on the sites in this area, a consultation process would be initiated with the South Carolina State Historic Preservation Officer to formally determine the eligibility of specific sites and to determine necessary and appropriate mitigation measures.

A survey of S-Area in conjunction with the 1982 DWPF EIS revealed no archaeological resources potentially eligible for nomination to the National Register (DOE 1994c:3–37).

3.5.9.3 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.

3.5.9.3.1 General Site Description

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, respectively, 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 (DOE 1996a:3-249).

Native American resources in the region include remains of villages or townsites, ceremonial lodges, burials, cemeteries, and natural areas containing traditional plants used in religious ceremonies. Literature reviews and consultations with Native American representatives have revealed 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 (DOE 1996a:3-249).

3.5.9.3.2 Proposed Facility Locations

In 1991, DOE conducted a survey of Native American concerns about religious rights in the central Savannah River valley. During this study, three Native American groups, the Yuchi Tribal Organization, the National Council of Muskogee Creek, and the Indian People's Muskogee Tribal Town Confederacy, expressed continuing interest in the SRS region with regard to the practice of their traditional religious beliefs. The Yuchi Tribal Organization and the National Council of Muskogee Creek have expressed concerns that several plant species—for example, redroot (*Lachnanthese carolinianum*), button snakeroot (*Erynglum yuccifolium*), and American ginseng (*Panax quinquefolium*)—traditionally used in tribal ceremonies could exist on SRS. Redroot and button snakeroot are known to occur on SRS, but are typically found in wet, sandy areas such as evergreen shrub bogs and savannas. Neither species is likely to be found in F-Area or S-Area due to clearing prior to the establishment of SRS in the 1950s (DOE 1994c:3-37). Consultations (see Chapter 5 and Appendix O) were initiated with appropriate Native American groups to determine any concerns associated with the actions evaluated in this SPD EIS.

3.5.9.4 Paleontological Resources

Paleontological resources are the physical remains, impressions, or traces of plants or animals from a former geological age.

3.5.9.4.1 General Site Description

Paleontological materials from the SRS area date largely from the Eocene Age (54 to 39 million years ago) and include fossil plants, numerous invertebrate fossils, giant oysters (*Crassostrea gigantissima*), other mollusks, and bryozoa. With the exception of the giant oysters, all other fossils are fairly widespread and common; therefore, the assemblages have low research potential or scientific value (DOE 1996a:3-249).

3.5.9.4.2 Proposed Facility Locations

No paleontological resources have been recorded for either F-Area or S-Area.

3.5.10 Land Use and Visual Resources

3.5.10.1 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, cultural, geological, aquatic, and atmospheric).

Located in southwestern South Carolina, SRS occupies an area of about 800 km^2 (310 mi^2) in a generally rural area about 40 km (25 mi) southeast of Augusta, Georgia, and 19 km (12 mi) south of Aiken, South Carolina, the nearest population centers (DOE 1996a:3-228). The site is owned by the Federal Government and is administered, managed, and controlled by DOE (DOE 1996a:3-230). It is bordered by the Savannah River to the southwest and includes portions of three South Carolina counties: Aiken, Allendale, and Barnwell (DOE 1996a:3-230).

3.5.10.1.1 General Site Description

Forest and agricultural land predominate in the areas bordering SRS. There are also significant open water and nonforested wetlands along the Savannah River Valley. Incorporated and industrial areas are the only other significant land uses. There is limited urban and residential development bordering SRS. The three counties in which SRS is located have not zoned any of the site land. The only adjacent area with any zoning is the town of New Ellenton, which has lands in two zoning categories bordering SRS: urban development and residential development. The closest residences are to the west, north, and northeast, within 60 m (200 ft) of the site boundary (DOE 1996a:3-230).

Various industrial, manufacturing, medical, and farming operations are conducted in areas around the site. Major industrial and manufacturing facilities in the area include textile mills, plants producing polystyrene foam and paper products, chemical processing plants, and a commercial nuclear power plant. Farming is diversified in the region; it includes crops such as peaches, watermelon, cotton, soybeans, corn, and small grains (DOE 1995b:vol. 1, app. C, 4-2).

Outdoor public recreation facilities are plentiful and varied in the SRS region. Included are the Sumter National Forest, 75 km (47 mi) to the northwest; Santee National Wildlife Refuge, 80 km (50 mi) to the east; and Clarks Hill/Strom Thurmond Reservoir, 70 km (43 mi) to the northwest. There are also a number of State, county, and local parks in the region, most notably Redcliffe Plantation, Rivers Bridge, Barnwell and Aiken County State Parks in South Carolina, and Mistletoe State Park in Georgia (DOE 1995b:vol. I, app. C, 4-2). The Crackerneck Wildlife Management Area, which extends over 1,930 ha (4,770 acres) of SRS adjacent to the Savannah River, is open to the public for hunting and fishing. Public hunts are allowed under DOE Order 4300.1C, which states that "all installations having suitable land and water areas will have programs for the harvesting of fish and wildlife by the public" (Noah 1995:48). SRS is a controlled area, public access being limited to through traffic on South Carolina Highway 125 (SRS Road A), U.S. Highway 278 (SRS Road 1), and the CSX railway line (DOE 1995b:vol. 1, app. C, 4-2).

Land use at SRS can be classified into three major categories: forest/undeveloped, water/wetlands, and developed facilities. Generalized land uses at SRS and vicinity are shown on Figure 3–33. Approximately

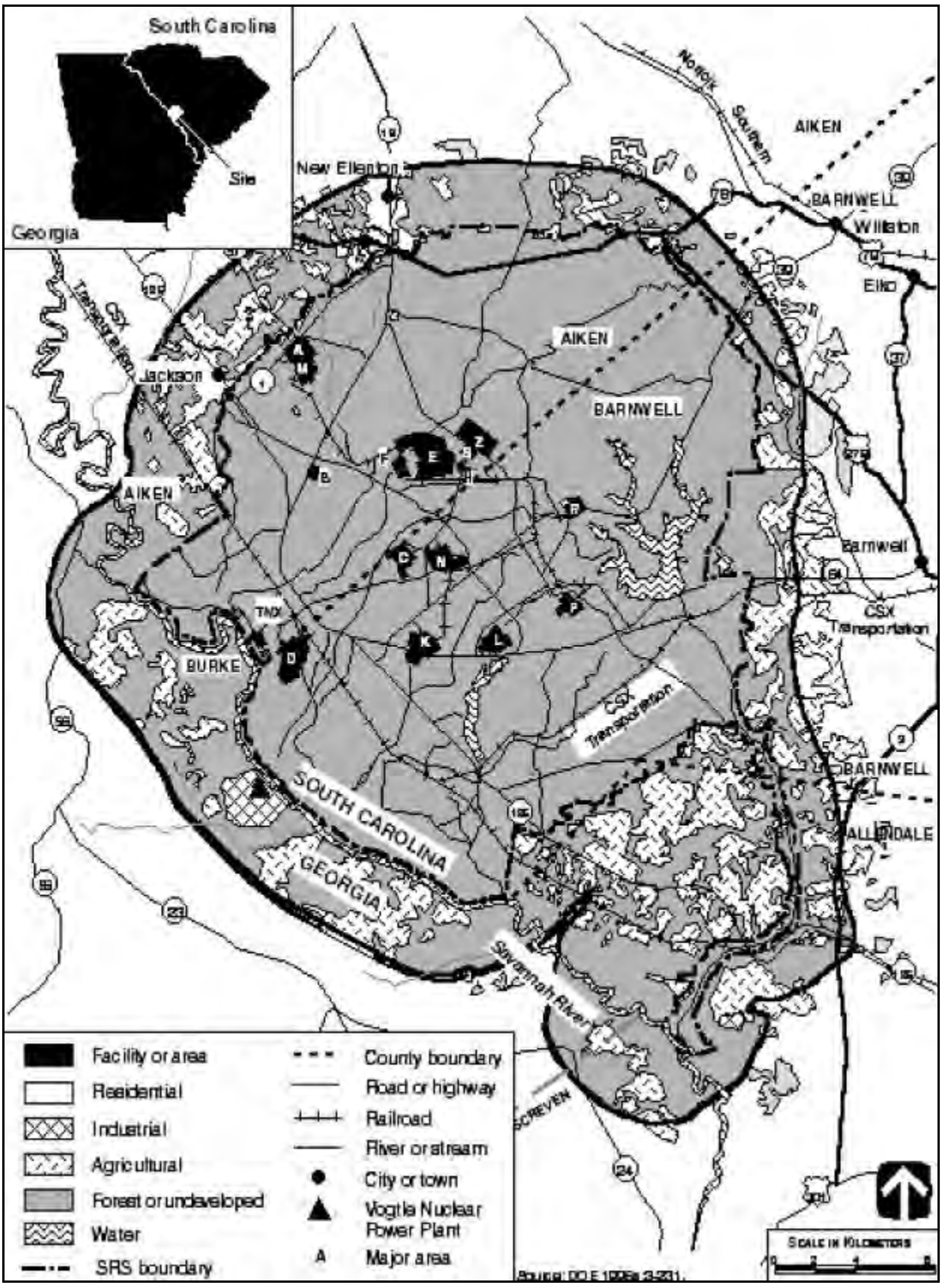


Figure 3–33. Generalized Land Use at SRS and Vicinity

585 km^2 (226 mi^2) of SRS—i.e., 73 percent of the area—is undeveloped (DOE 1996a:3-230). Wetlands, streams, and lakes account for 180 km^2 (70 mi^2) or 22 percent of the site, while developed facilities including production and support areas, roads, and utility corridors only make up approximately 5 percent or 40 km^2 (15 mi^2) of SRS (DOE 1996a:3-230). The woodlands area is primarily in revenue-producing, managed timber production. The U.S. Forest Service, under an interagency agreement with DOE, harvests about 7.3 km^2 (2.8 mi^2) of timber from SRS each year (DOE 1997e:4-57). Soil map units that meet the requirements for prime farmland soils exist on the site. However, the U.S. Department of Agriculture, Natural Resources Conservation Service, does not identify these as prime farmlands because the land is not available for agricultural production (DOE 1996a:3-230).

In 1972, DOE designated all of SRS as a National Environmental Research Park. The National Environmental Research Park is used by the national scientific community to study the impacts of human activities on the cypress swamp and hardwood forest ecosystems (DOE 1996a:3-230). DOE has set aside approximately 57 km^2 (22 mi^2) of SRS exclusively for nondestructive environmental research (DOE 1997e:4-57). A portion of SRS is open to the public for hunting and fishing.

Decisions on future land uses at SRS are made by DOE through the site development, land use, and future planning processes. SRS has established a Land Use Technical Committee composed of representatives from DOE, Westinghouse Savannah River Company, and other SRS organizations. DOE prepared the *FY 1994 Draft Site Development Plan*, which describes the current SRS mission and facilities, evaluates possible future missions and requirements, and outlines a master development plan that is now being prepared. In January 1996a, DOE published the *SRS Future Use Project Report*, which summarizes stakeholder-preferred future use recommendations that DOE considers throughout future planning and decisionmaking activities (DOE 1997e:4-57).

The State of South Carolina, through Act 489, as amended in 1994, requires local jurisdictions 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 (DOE 1996a:3-230). The counties of Aiken, Allendale, and Barnwell together constitute part of the Lower Savannah River Council of Governments. Private lands bordering SRS are subject to the planning regulations of these three counties.

No onsite areas are subject to Native American Treaty Rights. However, five Native American groups, the Yuchi Tribal Organization, the National Council of Muskogee Creek, the Indian Peoples Muskogee Tribal Town Confederacy, the Pee Dee Indian Association, and the Ma Chis Lower Alabama Creek Indian Tribe, have expressed concern over sites and items of religious significance on SRS. DOE routinely notifies these organizations about major planned actions at SRS and asks them to comment on SRS documents prepared in accordance with NEPA.

3.5.10.1.2 Proposed Facility Locations

Many buildings are situated within F-Area. Included is Building 221–F, one of the canyons where plutonium was recovered from targets during DOE's plutonium production phase. Land use at Building 221–F in F-Area is classified as heavy industrial. This 30-m (100-ft) concrete structure is designed for plutonium immobilization. F-Area occupies approximately 160 ha (395 acres) of the site; S-Area, 110 ha (272 acres). These areas are about 14 km (8.7 mi) and 10 km (6.2 mi), respectively, from the site boundary.

Also within F-Area will be the Actinide Packaging and Storage Facility (if built), a planned below-grade facility for receiving and storing Category I quantities of special nuclear material (UC 1999). For those alternatives that involve installing the plutonium conversion and immobilization facilities at SRS, DWPF in S-Area would provide the second-stage immobilization services (DOE 1994c:3-29).

3.5.10.2 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.

3.5.10.2.1 General Site Description

The dominant viewshed in the vicinity of SRS consists mainly of agricultural land and forest, with some limited residential and industrial areas. The SRS landscape is characterized by wetlands and upland hills. 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. These facilities are generally not visible offsite, as views are limited by rolling terrain, normally hazy atmospheric conditions, and heavy vegetation. The only areas visually impacted by the DOE facilities are those within the view corridors of State Highway 125 and SRS Road 1.

The developed areas and utility corridors (transmission lines and aboveground pipelines) of SRS are consistent with a VRM Class IV designation. The remainder of SRS is consistent with VRM Class III or IV (DOE 1996a:3-230; DOI 1986a, 1986b).

3.5.10.2.2 Proposed Facility Locations

Industrial facilities within F-Area consist of large concrete structures, smaller administrative and support buildings, and parking lots (DOE 1994c:3-38). The structures range in height from 3 to 30 m (10 to 100 ft), with a few stacks and towers that reach 60 m (200 ft). The facilities in this area are brightly lit at night and visible when approached via SRS access roads. Visual resource conditions in F-Area are consistent with VRM Class IV (DOI 1986a, 1986b; Sessions 1997c:sec. 2.1, table 2-1). F-Area is about 7 km (4.3 mi) from State Highway 125 and 8.5 km (5.3 mi) from SRS Road 1. Public view of F-Area facilities is restricted by heavily wooded areas bordering segments of the SRS Road 1 system and site-crossing State Highway 125. Moreover, those facilities are not visible from the Savannah River, which is about 10 km (6.2 mi) to the west.

Industrial facilities within S-Area consist of large concrete buildings, smaller administrative and support buildings, and parking lots (DOE 1994c:3-38). The facilities in this area are brightly lit at night and visible when approached via SRS access roads. Visual resource conditions in S-Area are consistent with a VRM Class IV designation (DOI 1986a, 1986b; Sessions 1997c:sec. 2.1, table 2-1). S-Area is about 10 km (6.2 mi) from State Highway 125 and 11 km (6.8 mi) from SRS Road 1. Public view of S-Area facilities is restricted by heavily wooded areas bordering segments of the SRS Road 1 system and site-crossing State Highway 125. Moreover, those facilities are not visible from the Savannah River, which is about 15 km (9.3 mi) to the west.

3.5.11 Infrastructure

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.

3.5.11.1 General Site Description

SRS comprises numerous research, processing, and administrative facilities. An extensive infrastructure system supports these facilities, as shown in Table 3–48.

Table 3–48. SRS Sitewide Infrastructure Characteristics

Resource	Current Usage	Site Capacity
Transportation		
Roads (km)	230	230
Railroads (km)	103	103
Electricity		
Energy consumption (MWh/yr)	420,000	5,200,000
Peak load (MW)	70	330
Fuel		
Natural gas (m^3/yr)	NA	NA
Oil (l/yr)	28,400,000	NA[a]
Coal (t/yr)	210,000	NA[a]
Water (l/yr)	1,780,000,000	3,870,000,000

[a] As supplies get low, more can be supplied by truck or rail.

Key: NA, not applicable.

Source: Sessions 1997a:2.

3.5.11.1.1 Transportation

SRS has an extensive network—230 km (143 mi)—of roads to meet its onsite intrasite transportation requirements. The railroad infrastructure, which consists of 103 km (64 mi) of track, provides for deliveries of large volumes of coal and oversized structural components (Table 3–48).

3.5.11.1.2 Electricity

The SRS electrical grid is a 115-kV system in a ring arrangement that supplies power to operating areas, administrative areas, and independent and support function areas. That system includes about 160 km (100 mi) of transmission lines. Power is supplied to the grid by three South Carolina Electric & Gas Company (SCE&G) transmission lines. SRS is situated in, and draws its power from, the Virginia-Carolina Sub-Region, an electric power pool area that is a part of the Southeastern Electrical Reliability Council. Most of that power comes from offsite coal-fired and nuclear-powered generating plants (Sessions 1997c:sec. 2.8).

Current site electricity consumption is about 420,000 MWh/yr. Site capacity is about 5.2 million MWh/yr. The peak load capacity is 330 MW; the peak load usage, 70 MW (Sessions 1997c:sec. 2.8).

3.5.11.1.3 Fuel

Coal and oil are used at SRS primarily to power the steam plants. Steam generation facilities at SRS include coal-fired powerhouses at A-, D-, and H-Areas and two package steam boilers, which use number 2 fuel oil, in K-Area. Coal is delivered by rail and is stored in coal piles in A-, D- and H-Areas. Oil is delivered by truck to K-Area. Coal is used to fuel A-Area powerhouse that provides process and heating steam for the main administrative area at SRS. D-Area powerhouse provides most of the steam for the SRS process area (Sessions 1998a). Natural gas is not used at SRS.

3.5.11.1.4 Water

A new central domestic water system serves the majority of the site. The system includes three wells and a 17-million-l/day (4.5-million-gal/day) water treatment plant in A-Area; two wells and an 8.3-million-l/day (2.2-million-gal/day) backup water treatment plant in B-Area; three elevated storage tanks; and a 43-km (27-mi)

piping loop (Sessions 1997c:sec. 2.8). The system's available flow capacity is approximately 13,060 1/min (3,450 gal/min) (DOE 1997f:3-35). Process water is provided to individual site areas. See Section 3.5.11.2.3 for more information.

3.5.11.1.5 Site Safety Services

The SRS fire department operates under a 12-hr rotational shift schedule, with three fire stations. Among the firefighters and officers are members of the SRS Hazardous Materials Response Team and the Rescue Team, responsible for rescues of all types. The fire department is supported by a fleet of 20 vehicles, including six pumpers, one pumper-tanker, one tanker, one aerial platform ladder truck, one light duty rescue vehicle, one mini-pumper for grass fires, one specially prepared emergency response step van and trailer for hazardous materials response, and two boats for waterway spill response and control. Inspections are performed periodically according to National Fire Protection Codes and Standards (WSRC 1994).

3.5.11.2 Proposed Facility Locations

A summary of the infrastructure characteristics for F-Area and S-Area is provided in Table 3–49.

Table 3–49. SRS Infrastructure Characteristics for F-Area and S-Area

	F-Area		S-Area	
Resource	**Current Usage**	**Capacity**	**Current Usage**	**Capacity**
Electricity				
Energy consumption (MWh/yr)	78,300	561,000	37,400	385,000
Peak load (MW)	14.5	64.0	6.0	14.5
Fuel				
Natural gas (m^3/yr)	NA	NA	NA	NA
Oil (l/yr)	NA	NA	NA	NA
Coal (t/yr)	NA	NA	NA	NA
Water (l/yr)	374,000,000	1,590,000,000	49,800,000	797,000,000

Key: NA, not applicable.
Source: Sessions 1997a.

3.5.11.2.1 Electricity

Electric power for F-Area is provided by the 200–F Power Loop, which is supplied by the 251–F electrical substation. This substation consists of two 115/13.8-kV, 24/32-MVA transformers and associated switchgear. The 13.8-kV power is distributed through a 2,000-A–rated bus (Sessions 1997c:sec. 2.8). F-Area electrical energy consumption is about 78,300 MWh/yr; F-Area electrical capacity, about 561,000 MWh/yr (Sessions 1997a).

Electric power for S-Area is provided by two 13.8-kV feeders supplied by the 251–H electrical substation. This substation consists of two 115/13.8-kV, 24/32-MVA transformers and associated switchgear. The 13.8-kV power is distributed through two 2,000-A–rated buses. The 13.8-kV bus tie breaker is normally closed. S-Area electrical energy consumption is about 37,400 MWh/yr; electrical capacity in S-Area, about 385,000 MWh/yr (Sessions 1997a; 1997c:sec. 2.8).

3.5.11.2.2 Fuel

Coal and oil are not required in F- or S-Area because steam is supplied from the central facility, and electricity is supplied from the site electrical grid system (Sessions 1998b).

3.5.11.2.3 Water

F-Area water usage of domestic water is about 374 million l/yr (100 million gal/yr) from the new central domestic water system. Currently available capacity for F-Area is about 1.6 billion l/yr (420 million gal/yr) (Sessions 1997a; 1997c:sec. 2.8).

S-Area has managed its supply of water until recently and has used an average of 50 million l/yr (13 million gal/yr). Now that it is connected to the new central domestic water system, the area has access to the system's excess capacity of 797 million l/yr (211 million gal/yr) (Sessions 1997a; 1997c:sec. 2.8).

Process and service water are supplied through deep-well systems within site areas. Wells 905-100F and 905-102F supply process and service water to F-Area; wells 905-1S and 905-2S to S-Area's DWPF. These wells are screened in the McQueen Branch (Lower Tuscaloosa) aquifer (Sessions 1997c:sec. 2.8). Each of these process water systems is capable of delivering 1,987 million 1/yr (525 million gal/yr) of water (Sessions 1997a; 1997c:sec 2.8). Current usage of process and service water in F-Area is 481 million 1/yr (127 million gal/yr) and about 3.79 million 1/yr (1 million gal/yr) in S-Area (Sessions 1997a).

3.6 LEAD ASSEMBLY FABRICATION AND POSTIRRADIATION EXAMINATION SITES

3.6.1 Hanford Overview

Hanford is located in the southeast portion of Washington State, occupying about 1,450 km^2 (560 mi^2). The 400 Area occupies 0.6 km^2 (0.2 km^2). Additional information on Hanford and the 400 Area is provided in Section 3.2.

[Text deleted.]

The options proposed for lead assembly fabrication at Hanford would use existing employees and buildings; therefore, major facility modifications would not be required. For this reason, detailed descriptions of environmental resources such as geology and soils, water, ecological, cultural and paleontological, land use and visual, socioeconomics, and environmental justice are not required for the 400 Area. For additional information on the resource areas that could be impacted by lead assembly fabrication activities in the 400 Area, refer to Sections 3.2.1, 3.2.2, 3.2.4, and 3.2.11.

3.6.2 ANL–W Overview

Located in the southeast portion of INEEL is ANL–W. ANL–W is about 328 ha (820 acres). Atomic City, 29 km (18 mi) southwest, is the closest populated area to ANL–W; it has a population of 25. Idaho Falls, population of about 45,000, is 63 km (39 mi) east of ANL–W (see Figure 2–3). In 1997, about 700 employees worked at ANL–W (O'Connor et al. 1998b).

Established in the mid-1950s, the primary mission of the ANL–W was to support advanced liquid metal reactor research (DOE 1996h:Idaho 4). In 1995, ANL–W began a Redirected Nuclear Research and Development Program to conduct research in the treatment of DOE spent nuclear fuel and reactor decontamination and decommissioning technologies (O'Connor et al. 1998b).

[Text deleted.]

The options proposed for lead assembly fabrication and postirradiation examination at ANL–W would occur in existing facilities that would not require major modifications and would use existing employees. For this reason, detailed descriptions of environmental resources such as geology and soils, water, ecological, cultural and paleontological, land use and visual, socioeconomics, and environmental justice are not provided. For more information on these resource areas, refer to Section 3.3. The resource areas that could be impacted by lead assembly fabrication activities are air quality, waste management, existing human health risk, and infrastructure. These resource areas are described below.

3.6.2.1 Air Quality

The meteorological conditions at INEEL are considered to be representative for ANL–W. Emissions of criteria pollutants at ANL–W result from the ongoing operation of onsite boilers used to produce steam for heating. Existing ambient air pollutant concentrations at INEEL are in compliance with applicable guidelines and regulations. See Section 3.3.1 for additional information on air quality for areas surrounding INEEL.

3.6.2.2 Waste Management

ANL–W analyzes, stores, and ships TRU waste, hazardous waste, mixed waste, LLW, and nonhazardous waste generated by the numerous research and support facilities at INEEL (O'Connor et al. 1998b).

The Waste Characterization Area, in the ANL–W Hot Fuels Examination Facility, is a glovebox facility used for characterization of TRU. The Radioactive Scrap and Waste Facility, in the northeast corner of ANL–W, provides underground vault storage for remote-handled LLW, mixed LLW, and TRU waste. The Radioactive Scrap and Waste Facility is a State of Idaho RCRA-permitted facility (O'Connor et al. 1998b).

The Radioactive Sodium Storage Facility is in an ANL–W controlled access area. The Radioactive Sodium Storage Facility is a RCRA-permitted storage facility used to store radioactive and heavy metal contaminated debris along with sodium and sodium-potassium alloy mixed waste (O'Connor et al. 1998b).

The sanitary wastewater treatment facility, 6,057-m^3/yr (21,390-ft^3/yr) capacity, is the only waste treatment facility at ANL–W. Other forms of waste generated at ANL–W are treated and disposed of at INEEL waste facilities or shipped off the site (O'Connor et al. 1998b). More information on waste management activities at INEEL can be found in Section 3.3.2.

3.6.2.3 Existing Human Health Risk

See Section 3.3.4 for major sources and levels of background radiation, mean concentrations of radiological releases, and offsite estimated dose rates to individuals within the vicinity of INEEL. Site worker radiological exposure data at ANL–W for 1994–1996 is provided in Table 3–50. Worker exposure limits at ANL–W remain within applicable limits.

Table 3–50. Worker Exposure Data for ANL–W, 1994–1996

	Radiation Worker Dose		All Workers	
Year	(mrem)	(person-rem)	(mrem)	(person-rem)
1994	34	28	19	34
1995	50	41	27	43
1996	56	45	31	45

Key: ANL–W, Argonne National Laboratory–West.
Source: O'Connor et al. 1998b.

3.6.2.4 Infrastructure

The site infrastructure at ANL–W includes those utilities and other resources required to support construction and continued operation of mission-related facilities. Table 3–51 shows facility infrastructure information for the proposed facility location. An adequate infrastructure exists at ANL–W to support current activities. See Section 3.3.11 for more detailed information on INEEL's infrastructure.

3.6.3 LLNL Overview

LLNL is composed of two sites: Livermore Site and Site 300 (see Figure 2–31). The Livermore Site is about 80 km (50 mi) east of San Francisco and 6.4 km (4 mi) from downtown Livermore. It occupies about 332 ha (821 acres) of flat terrain in the Livermore Valley. Site 300 is about 24 km (15 mi) southeast of the Livermore Site (DOE 1996h:California 67; 1996i:4-328).

Table 3–51. ANL–W Infrastructure Characteristics

Resource	Current Usage
Electricity	
Energy consumption (MWh/yr)	4,200
Peak load (MWe)	5,088
Fuel	
Natural gas (m^3/yr)	0
Liquid (m^3)	0
Coal (t/yr)	0
Steam (kg/h)	690
Water	
Annual (l/yr)	1,500,000
Peak (l/yr)	2,000,000

Key: ANL–W, Argonne National Laboratory–West.
Source: O'Connor et al. 1998b:S-10.

Originally used as a naval air training station, the Livermore Site was established in 1952 to conduct nuclear weapons research. Site 300 is a remote high-explosives testing facility. The current mission of LLNL is research, testing, and development that focuses on national defense and security, energy, the environment, and biomedicine (DOE 1996h:California 69). Within recent years, LLNL's mission has broadened to include global security, ecology, and mathematics and science education. In early 1998, LLNL had about 7,700 employees (O'Connor et al. 1998c).

[Text deleted.]

The options proposed for lead assembly fabrication at LLNL would occur in existing facilities that would not require major modifications and would use existing employees. For this reason, detailed descriptions of environmental resources such as geology and soils, water, ecological, cultural and paleontological, land use and visual, socioeconomics, and environmental justice are not provided. For a detailed discussion of these resource areas, refer to the *Stockpile Stewardship and Management Final PEIS* (DOE 1996i). The resource areas that could be impacted by lead assembly fabrication activities are air quality, waste management, existing human health risk, and infrastructure. These resource areas are described below.

3.6.3.1 Air Quality

The Livermore Site is in the San Francisco Bay Area Air Quality Management District. This area is designated as attainment for all criteria pollutants with respect to attainment of the NAAQS (EPA 1998b); however, EPA has recently redesignated the area as nonattainment for ozone (EPA 1998c). The emissions of criteria air pollutants at the Livermore Site result from the ongoing operation of numerous boilers for heating; solvent cleaning operations; emergency generators; and various experimental, testing, and process sources. The Bay Area Air Quality Management District and the San Joaquin Valley Unified Air Pollution Control District requested that the Livermore Site assess the impact of toxic air emissions on the surrounding area. The risks at the Livermore Site were found to be below the threshold values used to determine the need for additional evaluation (DOE 1996i:4-334). For a detailed discussion of this resource area, refer to Section 4.7.2.3 of the *Stockpile Stewardship and Management Final PEIS* (DOE 1996i:4-333).

3.6.3.2 Waste Management

LLNL was added to EPA's National Priorities List in July 1987 based on the presence of volatile organic compounds in the groundwater. In November 1988, DOE, EPA, the California Department of Health Services, and the Bay Area Regional Water Quality Control Board signed an FFCA to facilitate compliance with CERCLA, the Superfund Amendments and Reauthorization Act, and applicable State laws. In a remedial investigation/feasibility study prepared pursuant to CERCLA, DOE outlined its cleanup strategy for the LLNL Livermore Site. A ROD issued on July 15, 1992, included an announcement of DOE's decision to pump and treat contaminated groundwater and construct approximately seven small treatment facilities. The selected remedies address the principal concerns at LLNL by removing the contaminants from soil and groundwater and treating the effluents to the extent necessary for protection of human health and the environment (O'Connor et al. 1998c:3).

Through its research and operation activities, LLNL treats, stores, packages, and prepares TRU, low-level, mixed low-level, hazardous, and nonhazardous wastes for transport. Waste is treated and stored on the site and then shipped off the site for additional treatment and disposal. No disposal of waste occurs at the Livermore Site (DOE 1996h:California 78). LLNL waste generation rates and inventories are shown in Table 3–52. Table 3–53 provides information on waste management facilities at LLNL.

Table 3–52. Waste Generation Rates and Inventories at LLNL

Waste Type	Generation Rate (m^3/yr)	Inventory (m^3)
TRU[a]	27	257
Contact-handled		
LLW	124	644
Mixed LLW[b]	353	454
Hazardous	579	NA[c]
Nonhazardous		
Liquid	456,000	NA[c]
Solid	4,280	NA[c]

[a] Includes mixed TRU waste.
[b] Includes TSCA mixed LLW.
[c] Generally, hazardous and nonhazardous wastes are not held in long-term storage.

Key: LLNL, Lawrence Livermore National Laboratory; LLW, low-level waste; NA, not applicable; TRU, transuranic; TSCA, Toxic Substances Control Act.

Source: DOE 1996i:4-400 for hazardous and nonhazardous waste; DOE 1996d:15, 16 for all other wastes.

For a more detailed discussion of waste management activities at the Livermore Site, refer to Section 4.7.2.10 of the *Stockpile Stewardship and Management Final PEIS* (DOE 1996i:4-358) or Section 4.15.2 of the *Final EIS and Environmental Impact Report for Continued Operation of LLNL and Sandia National Laboratories, Livermore* (DOE 1992:4-239).

Table 3–53. Waste Management Facilities at LLNL

Facility Name/Description	Capacity	Status	Applicable Waste Types				
			TRU	LLW	Mixed LLW	Haz	Non-Haz
Treatment facilities (m^3/yr)							
LLW size reduction	771	Online		X			
Building 513 and 514 Waste Treatment Facility[a]	2,012	Online		X	X	X	X
Decontamination and waste treatment facility	Not determined	Planned	X	X	X	X	X
Storage facilities (m^3)							
Building 233, 625	217	Online	X	X	X	X	X
Building 280	513	Online	X	X			X
Building 513, 514, area 612–2	222	Online		X	X	X	X
Area 612–1	1,086	Online	X	X	X	X	X
Area 612–4	169	Online	X	X	X	X	X
Area 612–5	760	Online	X	X	X	X	X
Area 612 tanks	57	Online		X	X	X	X
Building 612 lab packaging unit	16	Online		X	X	X	X
Building 614, 693	298	Online	X	X	X	X	X
612 yard, area 612–3	1,327	Online		X			X
Building 696	590	Online	X	X			X
Disposal facilities (m^3/yr)							
LLNL sanitary sewer	2,327,800	Online					X

[a] Treatment methods employed in Building 513 are solidification and shredding. Methods used in Building 514 are evaporation, blending, separation, gas adsorption, silver recovery, and wastewater treatment (Kielusiak 1998a).

Key: Haz, hazardous; LLNL, Lawrence Livermore National Laboratory; LLW, low-level waste; TRU, transuranic.

Source: Kielusiak 1998b.

3.6.3.3 Existing Human Health Risk

Major sources and levels of background radiation exposure to individuals in the vicinity of LLNL are shown in Table 3–54. Annual background radiation doses to individuals are expected to remain constant over time. Total dose to the population changes as population size changes. Background radiation doses are unrelated to LLNL operations.

Release of radionuclides to the environment from LLNL operations provides another source of radiation exposure to the population in the vicinity. Doses to the public resulting from these releases are shown in Table 3–55. These doses fall within regulatory limits (DOE 1993a) and are small when compared with background radiation exposure.

Using a risk estimator of 500 cancer deaths per 1 million person-rem (5×10^{-4} fatal cancer per person-rem) to the public (see Appendix F.10), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from LLNL operations in 1996 is estimated to be 4.7×10^{-8}. That is, the estimated probability of this person dying from cancer from radiation exposure from 1 year of LLNL operations is slightly less than 5 chances in 100 million.

Table 3–54. Sources of Radiation Exposure to Individuals in the LLNL Vicinity Unrelated to LLNL Operations

Source	Effective Dose Equivalent (mrem/yr)
Natural background radiation	
Internal terrestrial radiation	40
Cosmic radiation	30
External terrestrial radiation	30
Radon in homes (inhaled)	200
Other background radiation	
Diagnostic x rays and nuclear medicine	53
Weapons test fallout	<1
Nuclear fuel cycle	<1
Total	354

Key: LLNL, Lawrence Livermore National Laboratory.
Note: Values for radon and weapons test fallout are averages for the United States.
Source: Harrach et al.:12-18.

Table 3–55. Radiation Doses to the Public From Normal LLNL Operations in 1996 (Total Effective Dose Equivalent)

	Atmospheric Releases		Liquid Releases		Total	
Members of the Public	**Standard[a]**	**Actual**	**Standard[a]**	**Actual**	**Standard[a]**	**Actual**
Maximally exposed individual (mrem)[a]	10	0.093	4	0	100	0.093
Population within 80 km (person-rem)[b]	None	1.1	None	0	100	1.1
Average exposed individual within 80 km (mrem)[c]	None	0.000175	None	0	None	0.000175

[a] The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10-mrem/yr limit for airborne emissions is required by the Clean Air Act. The 4-mrem/yr limit is required by the Safe Drinking Water Act; for this SPD EIS, the 4-mrem/yr value is conservatively assumed to be the limit for the sum of doses from all liquid pathways. The total dose of 100 mrem/yr is the limit from all combined pathways. The 100-person-rem value for the population is given in proposed 10 CFR 834 (DOE 1993b).
[b] In 1996, this population was about 6.3 million.
[c] Obtained by dividing the population dose by the number of people living within 80 km (50 mi) of the site.
Key: LLNL, Lawrence Livermore National Laboratory.
Source: Harrach et al.:12-18.

According to the same risk estimator, 5.5×10^{-4} excess fatal cancer per year is projected in the population living within 80 km (50 mi) of LLNL. For perspective, this number can be compared with the number of fatal cancers expected in this population from all causes. The 1996 mortality rate associated with cancer for the entire population was 0.2 percent per year. Based on this national rate, the number of fatal cancers from all causes expected during 1996 in the population living within 80 km (50 mi) of LLNL was 13,000. This number of expected fatal cancers is much higher than the estimated 5.5×10^{-4} fatal cancer that could result from LLNL operations in 1996.

Workers at LLNL receive the same dose as the general public from background radiation; however, they receive an additional dose from normal operations. Table 3–56 includes average, maximally exposed, and total

occupational doses to LLNL workers from operations in 1997. These doses fall within radiological limits. Based on a dose-to-risk conversion factor of 400 fatal cancers per 1 million person-rem (4×10^{-4} fatal cancer

Table 3–56. Radiation Doses to Onsite Workers From Normal LLNL Operations in 1997 (Total Effective Dose Equivalent)

	Onsite Releases and Direct Radiation	
Occupational Personnel	**Standard[a]**	**Actual**
Average radiation worker (mrem)	None[b]	2.5
Maximally exposed worker (mrem)	5,000	1,144
Total workers (person-rem)[c]	None	18.2

[a] The radiological limit for an individual worker is 5,000 mrem/yr (DOE 1995a:para. 835.202); however, DOE's goal is to maintain radiological exposures as low as is reasonably achievable. Therefore, DOE has established an administrative control level of 2,000 mrem/yr (DOE 1994a:2-3); DOE must make reasonable attempts to maintain worker doses below this level.

[b] No standard is specified for an "average radiation worker"; however, the maximum dose that this worker may receive is limited to that given in footnote "a."

[c] The total number of badged workers at the site in 1997 was 7,300.

Key: LLNL, Lawrence Livermore National Laboratory.

Source: Zahn 1998.

per person-rem) among workers (see Appendix F), the number of excess fatal cancers to LLNL workers from normal operations in 1997 is estimated to be 0.0073.

More detailed information of the radiation environment, including background exposures and radiological releases and doses, is presented in the *LLNL Environmental Report for 1996* (Harrach et al. 1997). Concentrations of radioactivity in various environmental media (e.g., air and water) and animal tissues in the site region are also presented in the same reference.

3.6.3.4 Infrastructure

A summary of the infrastructure characteristics of LLNL is presented in Table 3–57. An adequate infrastructure exists at LLNL to support current activities.

Table 3–57. LLNL Infrastructure Characteristics

Resource	Current Usage[a]	Site Capacity
Electricity		
Energy consumption (MWh/yr)	295,919	100 MW peak
Fuel		
Natural gas (m^3/yr)	13,017,173	4,400 m^3/hr peak
Liquid (1/yr)	1,257,699	NA[b]
Coal (t/yr)	0	0
Water		
Annual (l/yr)	874,138,983	10,977,660 1/day peak

[a] Five-year average for FY93–97.

[b] As supplies get low, more can be supplied by truck.

Key: LLNL, Lawrence Livermore National Laboratory; NA, not applicable.

Source: O'Connor et al. 1998c.

3.6.4 LANL Overview

LANL occupies 11,300 ha (28,000 acres) of land in northern New Mexico (see Figure 2–29). Situated on the Pajarito plateau in the Jemez mountains, the closest population centers are the city of Los Alamos (population 12,000) and White Rock (population 8,000). The closest metropolitan area is Santa Fe (population 50,000), about 40 km (25 mi) southeast of LANL. In 1997, LANL had about 9,200 workers (DOE 1996a:3-304).

The laboratory was established in 1943 to design, develop, and test nuclear weapons. LANL's mission has expanded from the primary task of designing nuclear weapons to include nonnuclear defense programs and a broad array of nondefense programs. Current programs include R&D of nuclear safeguards and security, space nuclear systems, biomedicine, computational science, and lasers (DOE 1996a:3-304). LANL consists primarily of Technical Areas (TAs), of which 49 are actively in use (DOE 1997g:1).

[Text deleted.]

The options proposed for lead assembly fabrication at LANL would occur in existing facilities that would not require major modifications and would use existing employees. For this reason, detailed descriptions of environmental resources such as geology and soils, water, ecological, cultural and paleontological, land use and visual, socioeconomics, and environmental justice are not provided. For more information on these resource areas, refer to the *Storage and Disposition PEIS* (DOE 1996a). The resource areas that could be impacted by lead assembly fabrication activities are air quality, waste management, existing human health risk, and infrastructure. These resource areas are described below.

3.6.4.1 Air Quality

LANL is within the New Mexico Intrastate AQCR 157. None of the areas within LANL and its surrounding communities are designated as nonattainment areas with respect to any of the NAAQS (EPA 1997h). The criteria pollutants, nitrogen dioxide, carbon monoxide, volatile organic hydrocarbons, particulate matter, and sulphur dioxide make up about 79 percent of the stationary source emissions at LANL. The sources of these criteria pollutants are power plants, steam plants, asphalt plants, and space heaters. Toxic and other hazardous pollutants comprise the remaining 21 percent of emissions from stationary sources at LANL. These emissions are generated by equipment cleaning, coating processes, and acid baths. Concentrations of criteria and hazardous and toxic air pollutants are in compliance with applicable guidelines and regulations (DOE 1996a:3-310). For a detailed discussion of this resource area, refer to Section 3.9.3 of the *Storage and Disposition PEIS* (DOE 1996a:3–310).

3.6.4.2 Waste Management

Although not listed on the National Priorities List, LANL adheres to the CERCLA guidelines for environmental restoration projects that involve certain hazardous substances not covered by RCRA. LANL's environmental restoration program originally consisted of approximately 2,100 potential release sites. At the end of FY97, there remained only about 756 sites requiring investigation or remediation and 118 buildings awaiting decontamination and decommissioning. LANL's environmental restoration program is scheduled for completion in 2006 (LANL 1998:21).

Through its research and operation activities, LANL manages the following waste categories generated at 33 technical areas: TRU, low-level, mixed low-level, hazardous, and nonhazardous wastes (DOE 1996h:New Mexico 38; 1996i:4-272). LANL waste generation rates and inventories are presented in Table 3–58.

Table 3–58. Waste Generation Rates and Inventories at LANL

Waste Type	Generation Rate (m^3/yr)	Inventory (m^3)
TRU[a]		
Contact-handled	262	11,262
LLW	1,585	NA[c]
Mixed LLW [b]	90	6,801
Hazardous	942	NA[c]
Nonhazardous		
Liquid	692,857	
Solid	5,453	NA[c]

[a] Includes mixed TRU waste.

[b] Includes TSCA mixed LLW.

[c] Generally, LLW, hazardous, and nonhazardous wastes are not held in long-term storage.

Key: LANL, Los Alamos National Laboratory; LLW, low-level waste; NA, not applicable; TRU, transuranic; TSCA, Toxic Substances Control Act.

Source: DOE 1996a:3-339 for hazardous and nonhazardous waste; DOE 1996d:15, 16 for all other wastes.

LANL currently stores TRU waste on the site pending shipment to WIPP for disposal. The site also treats and disposes of LLW on the site. Mixed LLW is stored on the site pending treatment at a combination of onsite and offsite facilities. Hazardous waste is treated and stored on the site for offsite disposal. Nonhazardous solid wastes are shipped off the site for treatment and disposal. Nonhazardous liquid wastes are treated and disposed of on the site (DOE 1996a:3-337, 3-340, 3-341). See Table 3–59 for information on selected treatment, storage, and disposal facilities at LANL.

Table 3–59. Selected Waste Management Facilities at LANL

Facility Name/Description	Capacity	Status	Applicable Waste Types: TRU	Mixed TRU	LLW	Mixed LLW	Haz	Non-Haz
Treatment facilities (m^3/yr)								
TRU waste volume reduction	1,080	Online	X	X				
RAMROD & RANT facilities	1,050	Online	X	X				
LLW compaction	76	Online			X			
Sanitary Wastewater Treatment Plant	1,060,063	Online						X
Storage facilities (m^3)								
TA–54 TRU waste storage	24,355	Online	X	X				
LLW storage	663	Online			X			
Mixed LLW storage	583	Online				X		
Hazardous waste storage	1,864	Online					X	
Disposal facilities (m^3)								
TA–54 Area G LLW Disposal	252,500 [a]	Online			X			
Sanitary tile fields (m^3/yr)	567,750	Online						X

[a] Current inventory of 250,000 m^3 (8.8 million ft^3), therefore, capacity will be exhausted in the next 2 to 5 years (O'Connor et al. 1998d). The *LANL Site-Wide Final EIS* (DOE 1999b) evaluates alternatives for LLW disposal.

Key: Haz, hazardous; LANL, Los Alamos National Laboratory; LLW, low-level waste; RAMROD, Radioactive Materials Research, Operations, and Demonstration; RANT, Radioactive Assay and Nondestructive Test; TRU, transuranic.

Source: DOE 1996a:3-337–3-341; Triay 1999.

For a more detailed description of this resource area, see Section 3.9.10 of the *Storage and Disposition PEIS* (DOE 1996a), or Sections 2.2.2.14 and 2.2.2.15 of the *Site-Wide Environmental Impact Statement for Continued Operation of the Los Alamos National Laboratory* (DOE 1999b).

3.6.4.3 Existing Human Health Risk

Major sources and levels of background radiation exposure to individuals within the vicinity of LANL are shown in Table 3–60. Annual background radiation doses to individuals are expected to remain constant over time. Total dose to the population changes as population size changes. Background radiation doses are unrelated to LANL operations (DOE 1996a:3-334).

Table 3–60. Sources of Radiation Exposure to Individuals in the LANL Vicinity Unrelated to LANL Operations

Source	Effective Dose Equivalent (mrem/yr)
Natural background radiation	
Cosmic radiation	48
External terrestrial radiation	44
Neutron cosmic radiation	10
Internal terrestrial	40
Radon in homes (inhaled)	200
Other background radiation	
Diagnostic x rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	407

Key: LANL, Los Alamos National Laboratory.
Note: Value for radon is an average for the United States.
Source: DOE 1996a:3-333.

Release of radionuclides to the environment from LANL operations provides another source of radiation exposure to the population in the vicinity. The doses to the public resulting from these releases are shown in Table 3–61. These doses fall within regulatory limits (DOE 1993a) and are small when compared with background radiation exposure.

Using a risk estimator of 500 cancer deaths per 1 million person-rem (5×10^{-4} fatal cancer per person-rem) to the public (see Appendix F.10), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from LANL operations in 1995 is estimated to be 2.9×10^{-6}. That is, the estimated probability of this person dying from cancer from radiation exposure from 1 year of LANL operations is about three chances in one million (DOE 1998g:3-77).

According to the same risk estimator, 1.6×10^{-3} excess fatal cancer per year is projected in the population living within 80 km (50 mi) of LANL in 1995. For perspective, this number can be compared with the number of fatal cancers expected in this population from all causes. The 1996 mortality rate associated with cancer for the entire population was 0.2 percent per year. Based on this national rate, the number of fatal cancers from all causes expected during 1995 in the population living within 80 km (50 mi) of LANL was 482. This number of expected fatal cancers is much higher than the estimated 1.6×10^{-3} fatal cancers that could result from LANL operations in 1995 (DOE 1998g:3-77).

Table 3–61. Radiation Doses to the Public From Normal LANL Operations in 1995 (Total Effective Dose Equivalent)

	Atmospheric Releases		Liquid Releases		Total	
Members of the Public	**Standard[a]**	**Actual**	**Standard[a]**	**Actual[b]**	**Standard[a]**	**Actual[b]**
Maximally exposed individual (mrem)	10	5.1	4	0.58	100	5.7
Population within 80 km (person-rem)[c]	None	3.2	None	Negligible	100	3.2
Average individual within 80 km (mrem)[d]	None	0.013	None	Negligible	None	0.013

[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 Clean Air Act. The 4-mrem/yr limit is required by the Safe Drinking Water Act; for this SPD EIS, the 4-mrem/yr value is conservatively assumed to be the limit for the sum of doses from all liquid pathways. The total dose of 100 mrem/yr is the limit from all combined pathways. The 100-person-rem value for the population is given in proposed 10 CFR 834 (DOE 1993b).

[b] Actual dose values given in this column conservatively include all water pathways, not just drinking water.

[c] In 1995, this population was about 241,000.

[d] Obtained by dividing the population dose by the number of people living within 80 km (50 mi) of the site.

Key: LANL, Los Alamos National Laboratory.

Source: DOE 1998g:3-77.

Workers at LANL receive the same dose as the general public from background radiation; however, they receive an additional dose from normal operations. Table 3–62 includes average, maximally exposed, and total occupational doses to LANL workers from operations in 1991–1995. Based on a risk estimator of 400 fatal cancers per 1 million person-rem (4×10^{-4} fatal cancer per person-rem) among workers (see Appendix F), the average annual number of fatal cancers to LANL workers from normal operations during the 1991–1995 timeframe is estimated to be 0.066 (DOE 1998g:3-77).

Table 3–62. Radiation Doses to Onsite Workers From Normal Operations at LANL, 1991–1995 (Total Effective Dose Equivalent)

	Onsite Releases and Direct Radiation	
Occupational Personnel	**Standard[a]**	**Actual[b]**
Average radiation worker (mrem)	None[c]	16
Maximally exposed worker (mrem)	5,000	2,000
Total workers (person-rem)	None	165

[a] The radiological limit for an individual worker is 5,000 mrem/yr (DOE 1995a:para. 835.202); however, DOE's goal is to maintain radiological exposures as low as is reasonably achievable. Therefore, DOE has established an administrative control level of 2,000 mrem/yr (DOE 1994a:2-3); DOE must make reasonable attempts to maintain worker doses below this level.

[b] Annual doses are averaged over the 5-year period.

[c] No standard is specified for an "average radiation worker"; however, the maximum dose that this worker may receive is limited to that given in footnote "a."

Key: LANL, Los Alamos National Laboratory.

Source: DOE 1998g:3-77.

More detailed information of the radiation environment at LANL is presented in *Environmental Surveillance at Los Alamos During 1995* (UC 1996). Concentrations of radioactivity in various environmental media (e.g., air and water) and animal tissues in the site region are also presented in the same reference.

3.6.4.4 Infrastructure

A summary of the infrastructure characteristics of LANL is presented in Table 3–63. An adequate infrastructure exists at LANL to support current activities.

Table 3–63. LANL Infrastructure Characteristics

Resource	Current Usage
Electricity	
Energy consumption (MWh/yr)	372,145
Fuel	
Natural gas (m^3/yr)	43,414,560
Fuel oil (l/yr)	0
Steam (kg/h)	33,554
Water	
Annual (l/yr)[a]	5,490,000,000

[a] In 1994, LANL's water system had an annual demand of 80 percent of its current allotment of 6,830 million l/yr (1,804 million gal/yr) (DOE 1999b:4-182). Demand includes use by Los Alamos County and National Park Service. LANL alone used 1,843 million l (approximately 487 million gal).

Key: LANL, Los Alamos National Laboratory.
Source: DOE 1996a:3-308, 1999b:4-181, 4-182.

3.6.5 SRS Overview

SRS occupies about 806 km^2 (310 mi^2) in the southern portion of South Carolina, about 19 km (12 mi) south of Aiken, South Carolina (see Figure 2–5) (DOE 1996a:3-228). Additional information on SRS is presented in Section 3.5.

[Text deleted.]

The options proposed for lead assembly fabrication at SRS would use existing employees and buildings; therefore, major facility modifications would not be required. For this reason, detailed descriptions of environmental resources such as geology and soils, water, ecological, cultural and paleontological, land use and visual, socioeconomics, and environmental justice are not provided. The resource areas that could be impacted by lead assembly fabrication activities are air quality, waste management, existing human health risk, and infrastructure. These resource areas are described below.

3.6.5.1 Air Quality

The meteorological conditions at H-Area are considered to be representative for SRS. Existing ambient air pollutant concentrations at SRS are in compliance with applicable guidelines and regulations. See Section 3.5.1 for additional information on air quality for areas surrounding SRS.

3.6.5.2 Waste Management

TRU, low-level, mixed low-level, hazardous, and nonhazardous wastes are generated by R&D, production, and decontamination activities in H-Area. These wastes are managed at SRS facilities and at offsite locations, as

appropriate. The total quantities of waste generated and the inventories in storage at SRS are presented in Section 3.5.2. Three of the major waste management facilities located in H-Area are described below. Additional SRS waste management facilities are described in Section 3.5.2.

The Consolidated Incineration Facility is designed to incinerate solid and liquid LLW, mixed LLW, and hazardous waste. This H-Area facility has a capacity of 4,630 m^3/yr (6,056 yd^3/yr) of liquid waste and 17,830 m^3/yr (23,322 yd^3/yr) of solid waste (DOE 1996a:E-109).

Liquid LLW and mixed LLW generated in H-Area are conveyed to the F- and H-Area Effluent Treatment Facility for treatment. This facility has a capacity of 1,930,000 m^3/yr (2,524,000 yd^3/yr). Treated effluents are discharged to Upper Three Runs Creek in compliance with permit limits. Treatment residuals are concentrated by evaporation and stored in the H-Area tank farm for eventual treatment in the Z-Area Saltstone Facility. In that facility, wastes are immobilized with grout for onsite disposal (DOE 1996a:E-98, E-109).

Sanitary wastewater from H-Area is conveyed to the Central Sanitary Wastewater Treatment Facility for treatment and disposal. The H-Area sanitary sewer has a capacity of 136,274 m^3/yr (178,246 yd^3/yr) (O'Connor et al. 1998e), and the Central Sanitary Wastewater Treatment Facility has a capacity of 1,030,000 m^3/yr (1,347,000 yd^3/yr) (Sessions 1997a). More information on waste management activities at SRS is presented in Section 3.5.2.

3.6.5.3 Existing Human Health Risk

See Section 3.5.4 for major sources and levels of background radiation, mean concentrations of radiological releases, and offsite estimated dose rates to individuals within the vicinity of SRS.

3.6.5.4 Infrastructure

The site infrastructure at Building 221–H includes those utilities and other resources required to conduct mission-related activities. A summary of the infrastructure characteristics at Building 221–H is presented in Table 3–64. An adequate infrastructure exists at this facility to support current activities. See Section 3.5.11 for more detailed information on the infrastructure at SRS.

Table 3–64. Infrastructure Characteristics of Building 221–H at SRS

Resource	Current Usage
Electricity	
Energy consumption (MWh/yr)	120,000
Fuel	
Natural gas (m^3/yr)	NA
Fuel oil (l/yr)	NA
Coal (t/yr)	0
Water (l/yr)	380,000,0000

Key: NA, not applicable.
Source: O'Connor et al. 1998e.

3.6.6 ORR Overview

ORR, established in 1943 as one of the three original Manhattan Project sites, occupies about 13,974 ha (34,516 acres) west of Knoxville, Tennessee, in and around the city of Oak Ridge, Tennessee (DOE 1999g:S-9). ORR is composed of three separate operations areas: East Tennessee Technology Park

(ETTP), ORNL, and Y–12. ETTP serves as an operations center for ORR's environmental restoration and waste management programs. Y–12 engages in national security activities and manufacturing outreach to U.S. industries.

ORNL is one of the country's largest multidisciplinary laboratories and research facilities. Its primary mission is to perform leading-edge nonweapons R&D in energy, health, and the environment. Other missions include production of radioactive and stable isotopes not available from other production sources; fundamental research in a variety of sciences; research involving hazardous and radioactive materials; and radioactive waste disposal. The facilities that would be used for postirradiation examination are located at ORNL.

The options proposed for postirradiation examination at ORNL would occur in existing facilities that would not require major modifications and would use existing employees. For this reason, detailed descriptions of environmental resources such as geology and soils, water, ecological, cultural and paleontological, land use and visual, socioeconomics, and environmental justice are not provided. For a detailed discussion of these resource areas, refer to the *Storage and Disposition PEIS* (DOE 1996a) and the *Final EIS, Construction and Operation of the Spallation Neutron Source* (DOE 1999g). The resource areas that are discussed include air quality, waste management, existing human health risk, and infrastructure.

3.6.6.1 Air Quality

ORR is in the Eastern Tennessee and Southwestern Virginia Interstate AQCR (DOE 1996a:3-192). This area is designated as attainment for all criteria pollutants with respect to the NAAQS (DOE 1999g:4-17). The primary sources of criteria air pollutants at ORR are the steam plants at ETTP, ORNL, and Y–12. Other emissions sources include the Toxic Substances Control Act incinerator, various process sources, vehicles, temporary emissions from construction activities, and fugitive particulate emissions from coal piles (DOE 1996a:3-192). For a detailed discussion of this resource area, refer to Section 4.1.3 of the *Final EIS, Construction and Operation of the Spallation Neutron Source* (DOE 1999g:4-14).

3.6.6.2 Waste Management

ORR was added to EPA's National Priorities List on November 21, 1989. In January 1, 1992, DOE, EPA, and the Tennessee Department of Environmental Conservation signed an FFCA to facilitate compliance with RCRA and applicable State laws. This agreement coordinates ORR inactive site assessment and remedial actions. In addition, portions of the FFCA are applicable to operating waste management systems (DOE 1996a:3-219).

Through its research and operation activities, ORR treats, stores, packages, and prepares for transport TRU, low-level, mixed low-level, hazardous, and nonhazardous wastes and spent nuclear fuel. Most waste is treated and stored on the site and then shipped off the site for additional treatment and disposal (DOE 1996a:3-219–3-227). ORR waste generation rates and inventories are shown in Table 3–65. Table 3–66 provides information on waste management facilities at ORR. For a more detailed discussion of waste management activities at ORR, refer to Sections 3.6.10 and E.2.5 of the *Storage and Disposition PEIS* (DOE 1996a:3-219, E-63).

Table 3–65. Waste Generation Rates and Inventories at ORR[a]

Waste Type	Generation Rate (m^3/yr)	Inventory (m^3)
TRU[b]		
Contact-handled	9	1,339
LLW	5,181	18,414
Mixed LLW [c]	1,122	48,763
Hazardous	34,048	NA [d]
Nonhazardous		
Liquid	2,406,300	NA [d]
Solid	49,470	NA [d]

[a] Includes ETTP, ORNL, and Y–12.
[b] Includes mixed TRU waste.
[c] Includes TSCA mixed LLW.
[d] Generally, hazardous and nonhazardous wastes are not held in long-term storage.

Key: ETTP, East Tennessee Technology Park; ORNL, Oak Ridge National Laboratory; ORR, Oak Ridge Reservation; LLW, low-level waste; NA, not applicable; TRU, transuranic; TSCA, Toxic Substances Control Act.

Source: DOE 1996a:3-220–3-225 for hazardous and nonhazardous waste; DOE 1996d:15, 16 for all other wastes.

Table 3–66. Selected Waste Management Facilities at ORR

Facility Name/Description	Capacity	Status	Applicable Waste Types				
			TRU	LLW	Mixed LLW	Haz	Non-Haz
Treatment facilities (m^3/yr)							
TRU Waste Treatment Plant (ORNL)	620	Planned for 2001	X				
Waste Compactor Facility (ORNL)	11,300	Online		X			
TSCA Incinerator (ETTP)	15,700	Online			X	X	
Bldg K–1203 Sewage Treatment Plant	829,000	Online					X
Oak Ridge Sewage Treatment Plant	1,934,500	Online					X
Sanitary Wastewater Treatment Facility (ORNL)	414,000	Online					X
Storage facilities (m^3)							
TRU Waste Storage (ORNL)	1,760	Online	X				
LLW Storage (ETTP and ORNL)	51,850	Online		X			
Mixed Waste Storage (ETTP, ORNL, and Y–12)	231,753	Online			X		
Hazardous Waste Storage (ORNL and Y–12)	1,051	Online				X	
Disposal facilities (m^3)							
Industrial & sanitary landfill (Y–12)	1,100,000	Online					X

Key: ETTP, East Tennessee Technology Park; Haz, hazardous; ORNL, Oak Ridge National Laboratory; ORR, Oak Ridge Reservation; LLW, low-level waste; TRU, transuranic; TSCA, Toxic Substances Control Act.
Source: DOE 1996a:3-219–3-225, E-78–E-95.

3.6.6.3 Existing Human Health Risk

Major sources and levels of background radiation exposure to individuals in the vicinity of ORR are shown in Table 3–67. Annual background radiation doses to individuals are expected to remain constant over time. Total dose to the population changes as population size changes. Background radiation doses are unrelated to ORR operations.

Table 3–67. Sources of Radiation Exposure to Individuals in the ORR Vicinity Unrelated to ORR Operations

Source	Effective Dose Equivalent (mrem/yr)
Natural background radiation [a]	
Internal terrestrial radiation	40
Cosmic radiation	27
External terrestrial radiation	28
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	360

Source	Effective Dose Equivalent (mrem/yr)

[a] Hamilton et al. 1998.
[b] NCRP 1987.
Key: ORR, Oak Ridge Reservation.
Note: Value for radon is an average for the United States.

Release of radionuclides to the environment from ORR operations provides another source of radiation exposure to the population in the vicinity. Doses to the public resulting from these releases are shown in Table 3–68. These doses fall within regulatory limits (DOE 1993a) and are small when compared with background radiation exposure.

Using a risk estimator of 500 cancer deaths per 1 million person-rem (5×10^{-4} fatal cancer per person-rem) to the public (see Appendix F.10), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from ORR operations in 1997 is estimated to be $1.4x10^{-6}$. That is, the estimated probability of this person dying from cancer from radiation exposure from 1 year of ORR operations is slightly more than one chance in one million.

According to the same risk estimator, 0.0079 excess fatal cancer per year is projected in the population living within 80 km (50 mi) of ORR. For perspective, this number can be compared with the number of fatal cancers expected in this population from all causes. The 1996 mortality rate associated with cancer for the entire population was 0.2 percent per year. Based on this national rate, the number of fatal cancers from all causes expected during 1996 in the population living within 80 km (50 mi) of ORR was 1,760. This number of expected fatal cancers is much higher than the estimated 0.0079 fatal cancers that could result from ORR operations in 1997.

Table 3–68. Radiation Doses to the Public From Normal ORR Operations in 1997 (Total Effective Dose Equivalent)

	Atmospheric Releases		Liquid Releases		Total	
Members of the Public	**Standard[a]**	**Actual**	**Standard[a]**	**Actual**	**Standard[a]**	**Actual**
Maximally exposed individual (mrem)	10	0.41	4	1.4[b]	100	2.8[c]
Population within 80 km (person-rem)[d]	None	10.0	None	5.7	100	15.7
Average exposed individual within 80 km (mrem)[e]	None	0.011	None	0.0065	None	0.018

[a] The standards for individuals are given in DOE Order 5400.5. As discussed in that order, the 10-mrem/yr limit for airborne emissions is required by the Clean Air Act. The 4-mrem/yr limit is required by the Safe Drinking Water Act; for this SPD EIS, the 4-mrem/yr value is conservatively assumed to be the limit for the sum of doses from all liquid pathways. The total dose of 100 mrem/yr is the limit from all combined pathways. The 100-person-rem value for the population is given in proposed 10 CFR 834 (DOE 1993b).
[b] These doses are mainly from drinking water and eating fish from the Clinch River section of Poplar Creek.
[c] This total dose includes a conservative value of 1 mrem/yr from direct radiation exposure to a cesium field near the Clinch River.
[d] In 1997, this population was about 880,000.
[e] Obtained by dividing the population dose by the number of people living within 80 km (50 mi) of the site.
Key: ORR, Oak Ridge Reservation.
Source: Hamilton et al. 1998.

Workers at ORR receive the same dose as the general public from background radiation; however, they receive an additional dose from normal operations. Table 3–69 includes average, maximally exposed, and total

occupational doses to ORR workers from operations in 1997. These doses fall within radiological limits. Based on a dose-to-risk conversion factor of 400 fatal cancers per 1 million person-rem (4×10^{-4} fatal cancer per person-rem) among workers (see Appendix F), the number of excess fatal cancers to ORR workers from normal operations in 1997 is estimated to be 0.031.

Table 3–69. Radiation Doses to Onsite Workers From Normal ORR Operations in 1997 (Total Effective Dose Equivalent)

	Onsite Releases and Direct Radiation	
Occupational Personnel	**Standard[a]**	**Actual**
Average radiation worker (mrem)	None[b]	48
Total workers (person-rem)[c]	None	78

[a] The radiological limit for an individual worker is 5,000 mrem/yr (DOE 1995a:para. 835.202); however, DOE's goal is to maintain radiological exposures as low as is reasonably achievable. Therefore, DOE has established an administrative control level of 2,000 mrem/yr (DOE 1994a:2-3); DOE must make reasonable attempts to maintain worker doses below this level.

[b] No standard is specified for an "average radiation worker"; however, the maximum dose that this worker may receive is limited to that given in footnote "a."

[c] The total number of badged workers at the site in 1997 was 1,614.

Key: ORR, Oak Ridge Reservation.

Source: DOE 1999h.

More detailed information of the radiation environment, including background exposures and radiological releases and doses, is presented in the *ORR Annual Site Environmental Report for 1997* (Hamilton et al. 1998), and Section 4.1.9.1 of the *Final EIS, Construction and Operation of the Spallation Neutron Source* (DOE 1999g:4-60). Concentrations of radioactivity in various environmental media (e.g., air and water) and animal tissues in the site region are also presented in the *ORR Annual Site Environmental Report for 1997*.

3.6.6.4 Infrastructure

A summary of the infrastructure characteristics of ORR is presented in Table 3–70. An adequate infrastructure exists at ORR to support current activities. For a more detailed discussion of the site infrastructure, refer to Section 4.2.10.2 of the *Final EIS, Construction and Operation of the Spallation Neutron Source* (DOE 1999g:4-144), and Sections 3.6.2 and 3.6.4 of the *Storage and Disposition PEIS* (DOE 1996a:3-190,3-194).

Table 3–70. ORR Infrastructure Characteristics

Resource	Current Usage[a]	Site Capacity
Electricity		
Energy consumption (MWh/yr)	726,000	13,880,000
Fuel		
Natural gas (m^3/yr)	95,000,000	250,760,000
Liquid (1/yr)	416,000	416,000 [a]
Coal (t/yr)	16,300	16,300 [a]
Water		
Annual (l/yr)	14,210,000,000	44,347,500,000

[a] As supplies get low, more can be supplied by truck.

Key: ORR, Oak Ridge Reservation.

Source: DOE 1996a:3-190, 3-194.

3.7 REACTOR SITES FOR MOX FUEL IRRADIATION

3.7.1 Catawba Units 1 and 2 Site Overview

The Catawba nuclear power plant occupies 158 ha (391 acres) in York County, South Carolina, 9.3 km (5.8 mi) north-northwest of Rock Hill, South Carolina, and 16.9 km (10.5 mi) west-southwest of Charlotte, North Carolina (see Figure 3–34). The site is on a peninsula bounded by Beaver Dam Creek to the north, Big Allison Creek to the south, Lake Wylie to the east, and private property to the west (Duke Power 1997:2-3). Lake Wylie has a surface area of 5,040 ha (12,455 acres), a shoreline of approximately 523 km (325 mi), and a volume of 3.46×10^{8} m^3 (281,900 acre-ft). The towns of Mount Holly and Belmont, North Carolina, take their raw water supplies from Lake Wylie. The communities of Chester, Fort Lawn, Fort Mill, Great Falls, Lancaster, Mitford, Riverview, and Rock Hill, South Carolina, obtain at least a portion of their municipal water supplies from the Catawba River within 80 km (50 mi) downstream from the site (Duke Power 1997:2-41, table 2-52).

In 1997, the plant employed 1,232 persons (DOE 1999f). The Catawba reactors are operated by Duke Power Company. The operating licenses (Nos. NPF–35 and NPF–52) for Units 1 and 2 were granted in 1985 and 1986 and expire in 2024 and 2026, respectively (NRC 1997). The population within an 80-km (50-mi) radius of these reactors is estimated to be 1,656,093 (Duke Power 1997:table 2-13).

Reactor cooling is accomplished using mechanical draft cooling towers, with water obtained from Lake Wylie (Duke Power 1997). During normal operations of Catawba, cooling water is pumped from the Beaver Dam Creek arm of Lake Wylie at a rate of 266,680 million l/yr (70,450 million gal/yr) and returned to Big Allison Creek at a rate of 172,902 million l/yr (45,676 million gal/yr). The net difference in water (93,779 million l/yr [24,774 million gal/yr]) is due to evaporation in the cooling towers (DOE 1999f).

New (unirradiated) fuel assemblies are dry stored in racks located in the two New Fuel Storage Buildings. Each New Fuel Storage Building is designed to accommodate 98 fuel assemblies (a total of 196 assemblies). Spent (irradiated) fuel assemblies are stored in two spent fuel pools in the two fuel buildings. The spent fuel storage pools have a total capacity of 2,836 assemblies (Duke Power 1997:9-3–9-6). Security at the site is provided in accordance with U.S. Nuclear Regulatory Commission (NRC) regulations and includes security checkpoints, barbed wire fencing, surveillance cameras, and intruder detection. More information about these reactors can be found at the NRC Web site at http://www.nrc.gov/OPA/finder.htm (NRC 1999) and in NRC Docket Nos. 50–413 and 50–414.

3.7.1.1 Air Quality

Catawba is within the Metropolitan Charlotte, North Carolina, AQCR #167. None of the areas within the site or York County are designated as nonattainment areas with respect to the NAAQS for criteria air pollutants (EPA 1998d).

Sources of criteria air pollutants from Catawba include five emergency diesel generators, a safe shutdown facility generator, and miscellaneous equipment such as trucks and forklifts. Table 3–71 provides a summary of criteria pollutant concentrations from operations of Catawba. The concentrations resulting from operations are well below the applicable ambient air quality standards even when background concentrations from other offsite sources are considered.

3.7.1.2 Waste Management

Table 3–72 presents the 5-year average annual waste generation rates for Catawba.

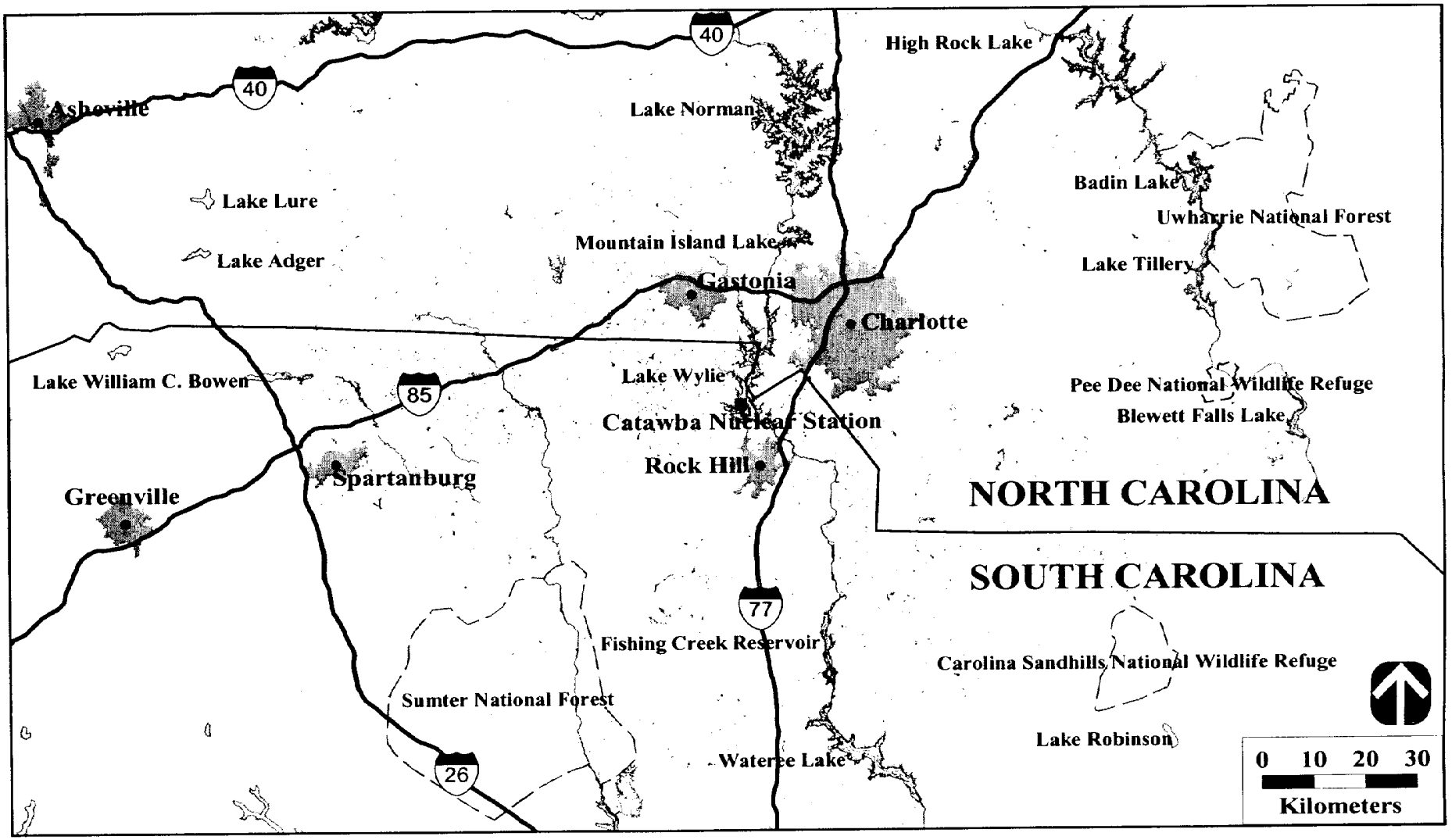


Figure 3–34. Catawba Nuclear Power Plant, South Carolina

Table 3–71. Comparison of Contribution to Nonradiological Ambient Air Pollutant Concentrations From Catawba Sources With National Ambient Air Quality Standards

Pollutant	Averaging Period	NAAQS (Fg/m³)	Catawba (Fg/m³)
Carbon monoxide	8 hours	10,000	978
	1 hour	40,000	1,400
Nitrogen dioxide	Annual	100	3.26
PM_{10}	Annual	50	0.102
	24 hours	150	65.9
$PM_{2.5}$	3-year annual	15	(a)
	24 hours (98th percentile over 3 years)	65	(a)
Sulfur dioxide	Annual	80	0.0418
	24 hours	365	26.9
	3 hours	1,300	60.4

[a] No data is available with which to assess $PM_{2.5}$ concentrations.

Key: NAAQS, National Ambient Air Quality Standards.

Note: Based on 1994–1995 emissions data for diesel generators.

Source: Modeled concentrations based on DOE 1999f; EPA 1997a.

Table 3–72. Annual Waste Generation for Catawba (m^3)

Waste Type	Generation Rate
LLW	50
Mixed LLW	0.6[a]
Hazardous waste	29[a]
Nonhazardous waste	
Liquid	60,794[b]
Solid	455[a]

[a] Values converted from kilograms assuming a waste density such that 1 m^3 = 1,000 kg.

[b] Assuming sanitary wastewater is generated at the same rate 365 days per year.

Key: LLW, low-level waste.

Source: DOE 1999f.

The waste disposal systems provide all equipment necessary to collect, process, store, and prepare for disposal of all radioactive liquid and solid wastes produced as a result of reactor operations. Potentially radioactive liquids may originate from a variety of sources, including the steam generator blowdown system, ventilation unit condensate system, drainage system sumps, laboratory drains, personnel decontamination area drains, decontamination system, sampling system, and laundry drains. Potentially radioactive liquid wastes are collected and characterized as to the level of contamination present. If contamination is below regulated levels, liquids may be discharged to the circulating water discharge outfall in accordance with the National Pollutant Discharge Elimination System (NPDES) permit. If liquids are determined to be radioactively contaminated, they are treated by filtration, evaporation, or mixing and settling, or are sent to the demineralizers, before being discharged. Continuous radiation monitoring is provided for treated liquid waste before its release to the circulating water discharge outfall. Liquid waste is analyzed and monitored to ensure that radionuclide concentrations are maintained as low as practical and well within the limits of applicable regulations and permits (Duke Power 1997:11-9–11-27).

The radioactive solid waste disposal system provides facilities for holdup, packaging, and storage of wastes before shipment to offsite licensed treatment and disposal facilities. Radioactive solid waste may include evaporator concentrates, spent demineralizer resins, spent filters, laboratory wastes, rags, gloves, boots, brooms, and other miscellaneous tools and apparel that become contaminated during normal plant operations and maintenance. Treatment on the site may include dewatering and compaction, or solidification using a contractor-supplied mobile unit. Materials that are compressible are placed in 208-l (55-gal) drums for compaction. Spent radioactive filter cartridges are packaged in either 114-l (30-gal) or 208-l (55-gal) drums. Packaged wastes are stored in the filter cartridge storage bunker, low-activity-waste storage room, high-activity-waste storage room, solidification area, and waste shipping area before being shipped to an offsite treatment or disposal facility (Duke Power 1997:11-53–11-61).

The small quantities of mixed low-level and hazardous wastes generated are accumulated on the site before being shipped for commercial treatment and disposal in offsite permitted facilities. Nonhazardous solid wastes are generated by typical industrial processes and housekeeping activities and are collected on the site and managed off the site at the local permitted sanitary landfill. Nonhazardous sanitary wastewater is treated in the onsite sanitary wastewater treatment facility and then discharged to Lake Wylie (Sadler 1997:6).

3.7.1.3 Existing Human Health Risk

Major sources and levels of background radiation exposure to individuals within the vicinity of Catawba are shown in Table 3–73. Annual background radiation doses to individuals are expected to remain constant over time. Total dose to the population changes as population size changes. Background radiation doses are unrelated to reactor operations.

Table 3–73. Sources of Radiation Exposure to Individuals in the Catawba Vicinity Unrelated to Catawba Operations

Source	Effective Dose Equivalent (mrem/yr)
Natural background radiation	
Cosmic and external and internal terrestrial radiation[a]	125
Radon in homes (inhaled)[b]	200[c]
Other background radiation[b]	
Diagnostic x rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	390

[a] Virginia Power 1998:11B-3.
[b] NCRP 1987:11, 40, 53.
[c] An average for the United States.

Releases of radionuclides to the environment from normal reactor operations provide another source of radiation exposure to populations within the vicinity of the site. The doses to the public resulting from these releases are shown in Table 3–74. These doses fall within regulatory limits and are small when compared with background exposure.

Using a risk estimator of 500 cancer deaths per 1 million person-rem (5×10^{-4} fatal cancer per person-rem) to the public (see Appendix F.10), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from normal reactor operations in 1997 is estimated to be 7.8×10^{-8}. That is, the estimated

Table 3–74. Radiological Impacts on the Public From Catawba Operations in 1997 (Total Effective Dose Equivalent)

	Atmospheric Releases		Liquid Releases		Total	
Members of the Public	**Standard[a]**	**Actual**	**Standard[a]**	**Actual**	**Standard[a]**	**Actual**
Maximally exposed individual (mrem)	5	0.045	3	0.11	25	0.16
Population within 80 km (person-rem)[b]	NA	4.0	NA	4.3	NA	8.3

[a] The standards for individuals are given in 10 CFR 50, Appendix I. The standard for the maximally exposed offsite individual (25 mrem/yr total body from all pathways) is given in 40 CFR 190.

[b] Population used: 1,656,093; this population dose was estimated for the year 2000 and is assumed to be representative for the year 1997.

Key: NA, not applicable.

Source: DOE 1999f; Duke Power 1997:tables 2-13, 11-12, and 11-15.

probability of this person dying from cancer from radiation exposure from 1 year of normal reactor operations is about 1 chance in 13 million.

According to the same risk estimator, 0.0042 excess fatal cancer is projected among the population living within 80 km (50 mi) of Catawba in 1997. For perspective, this number can be compared with the number of fatal cancers expected in this population from all causes. The 1996 mortality rate associated with cancer for the entire population was 0.2 percent per year (Famighetti 1998:964). Based on this national rate, the number of fatal cancers from all causes expected during 1997 in the population living within 80 km (50 mi) of Catawba was about 3,300. This number of expected fatal cancers is much higher than the estimated 0.0042 fatal cancer that could result from normal reactor operations in 1997.

Workers at the reactors receive the same background radiation dose as the general public; however, they receive an additional dose from normal operations of the reactors. Table 3–75 includes average, maximally exposed, and total occupational doses to reactor workers from operations in 1997. Based on a risk estimator of 400 cancer deaths per 1 million person-rem (4×10^{-4} fatal cancer per person-rem) among workers, the number of fatal cancers to reactor workers from 1997 normal operations is estimated to be 0.11.

Table 3–75. Radiological Impacts on Involved Workers From Catawba Operations in 1997

Number of badged workers[a]	3,420
Total dose (person-rem/yr)	265
Annual latent fatal cancers	0.11
Average worker dose (mrem/yr)	78
Annual risk of latent fatal cancer	3.1×10^{-5}

[a] A badged worker is equipped with an individual dosimeter.

Note: The radiological limit for an individual worker is 5,000 mrem/yr (10 CFR 20). An effective ALARA program would ensure that doses are reduced to levels that are as low as is reasonably achievable.

Source: DOE 1999f.

3.7.1.4 Environmental Justice

Environmental justice concerns the environmental impacts that proposed actions may have on minority and low-income populations, and whether such impacts are disproportionately high and adverse (CEQ 1997). In the case of Catawba, the potentially affected area includes parts of North Carolina and South Carolina.

The potentially affected area around Catawba is defined by a circle with an 80-km (50-mi) radius centered at these reactors (lat. 35E03N050 N, long. 81E04N100 W). The total population residing within that area in 1990 was 1,519,392. The proportion of the population that was considered minority was 20.7 percent. The same census data show that the percentage of minorities for the contiguous United States was 24.1, and the percentages of the States of North Carolina and South Carolina were 25.0 and 31.5, respectively (DOC 1992).

At the time of the 1990 census, Blacks were the largest minority group within the potentially affected area, constituting 19.0 percent of the total population. Asians and Hispanics contributed about 0.7 percent, and Native Americans made up about 0.3 percent of the population (DOC 1992).

A breakdown of incomes in the potentially affected area is also available from the 1990 census data (DOC 1992). At that time, the poverty threshold was $9,981 for a family of three with one related child under 18 years of age. A total of 159,956 persons (10.5 percent of the total population) residing within the potentially affected area around Catawba reported incomes below that threshold. Data obtained during the 1990 census also show that of the total population of the contiguous United States, 13.1 percent reported incomes below the poverty threshold and that the figures for North Carolina and South Carolina were 13.0 and 15.4 percent, respectively (DOC 1992).

3.7.2 McGuire Units 1 and 2 Site Overview

The McGuire nuclear power plant occupies 280 ha (700 acres) in northwestern Mecklenburg County, North Carolina, 27.4 km (17 mi) northwest of Charlotte, North Carolina (see Figure 3–35). The site is bounded to the west by the Catawba River and to the north by Lake Norman. Surrounding land is generally rural nonfarmland. Lake Norman, with a surface area of 13,156 ha (32,510 acres), a volume of 1,349 million m^3 (1,093,600 acre-ft) and a shoreline of 837 km (520 mi), stretches 54.7 km (34 mi) from Cowans Ford Dam to the tailrace of Lookout Lake. The Charlotte municipal water intake is 18 km (11.2 mi) downstream from the site (Duke Power 1996:2-3, 2-27, 2-28; Nesbit 1999; Ritchey 1996). In addition, the communities of Belmont, Gastonia, and Mount Holly, North Carolina, and Chester, Fort Lawn, Fort Mill, Lancaster, Mitford, Riverview, and Rock Hill, South Carolina, obtain at least a portion of their municipal water supplies from the Catawba River within 80 km (50 mi) downstream from the site (Duke Power 1997:2-41, table 2-52).

In 1997, the plant employed 1,238 persons (DOE 1999f). The McGuire reactors are operated by Duke Power Company. The operating licenses (Nos. NPF–9 and NPF–17) for these reactors were granted in 1981 and 1983, and expire in 2021 and 2023, respectively (NRC 1997). The population within an 80-km (50-mi) radius of these reactors is estimated to be 2,140,720 (Duke Power 1996:table 2-1). Reactor cooling is accomplished using a once-through cooling system. Cooling water is withdrawn from Lake Norman at a rate of 7,025,937 million l/yr (1,856,062 million gal/yr) and discharged back into Lake Norman at a rate of 6,966,567 million l/yr (1,840,378 million gal/yr). The net difference in water (59,370 million l/yr [15,684 million gal/yr]) is due to evaporation (DOE 1999f).

New (unirradiated) fuel assemblies are dry stored in racks located in the two New Fuel Storage Vaults. Each New Fuel Storage Vault is designed to accommodate 96 fuel assemblies (a total of 192 assemblies). Spent (irradiated) fuel assemblies are stored in two spent fuel pools in the two Auxiliary Buildings. The two spent fuel storage pools have a total capacity of 2,926 assemblies. New fuel can also be stored in the spent fuel pools (Duke Power 1996:9-3–9-8). Security at the site is provided in accordance with NRC regulations and includes security checkpoints, barbed wire fencing, surveillance cameras, and intruder detection. More information about these reactors can be found at the NRC Web site at http://www.nrc.gov/OPA/finder.htm (NRC 1999) and in NRC Docket Nos. 50–369 and 50–370.

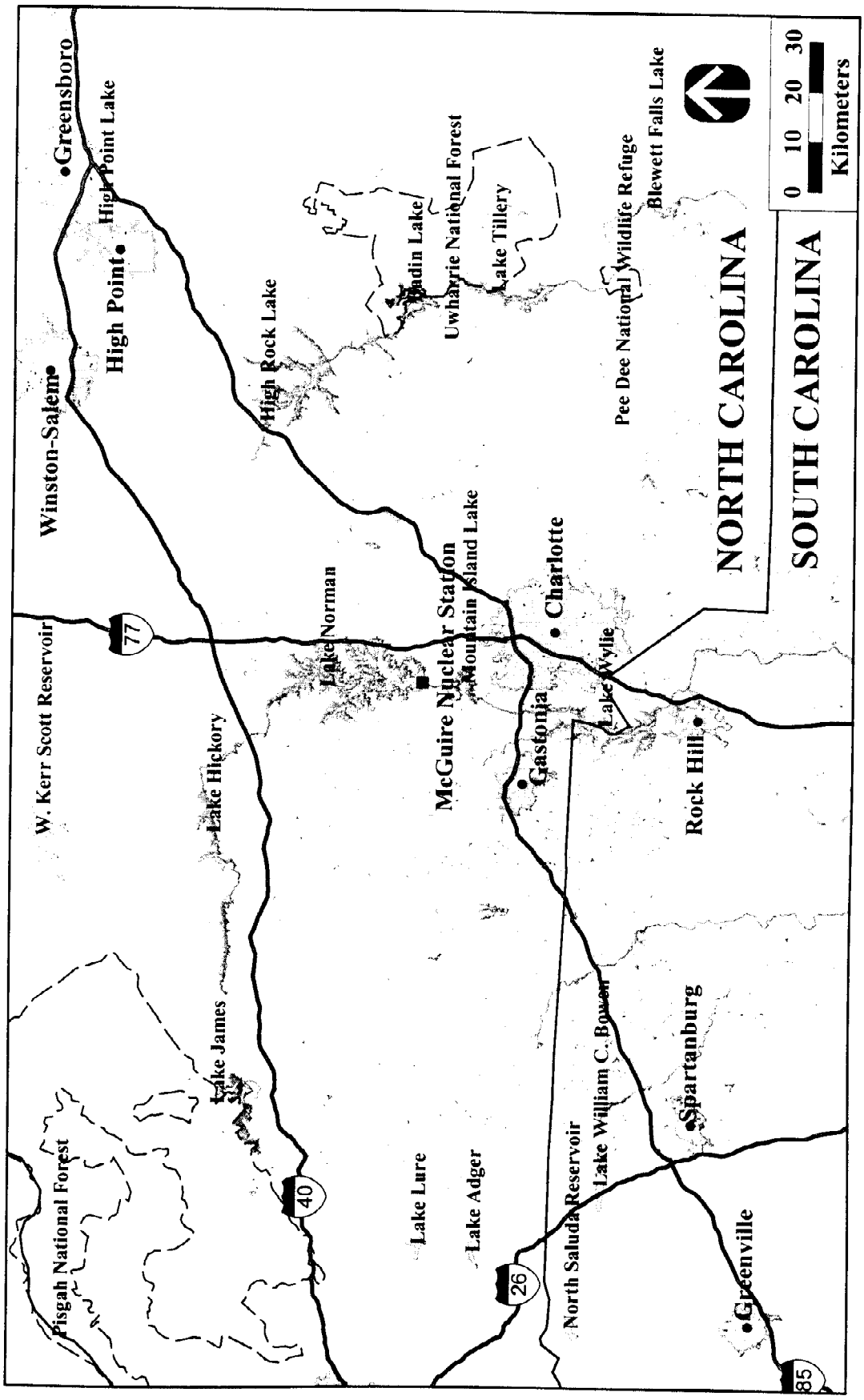


Figure 3-35. McGuire Nuclear Power Plant, North Carolina

3.7.2.1 Air Quality

McGuire is within the Metropolitan Charlotte AQCR #167. None of the areas within the site or Mecklenberg County are designated as nonattainment areas with respect to the NAAQS for criteria air pollutants (EPA 1998e).

Sources of criteria air pollutants from McGuire include five emergency diesel generators, a safe shutdown facility generator, and miscellaneous equipment such as trucks and forklifts. Table 3–76 provides a summary of criteria pollutant concentrations from operations of McGuire. The concentrations resulting from operations are well below the applicable ambient air quality standards even when background concentrations from other offsite sources are considered.

Table 3–76. Comparison of Contribution to Nonradiological Ambient Air Pollutant Concentrations From McGuire Sources With National Ambient Air Quality Standards

Pollutant	Averaging Period	NAAQS (Fg/m^3)	McGuire (Fg/m^3)
Carbon monoxide	8 hours	10,000	1,060
	1 hour	40,000	1,510
Nitrogen dioxide	Annual	100	2.55
PM_{10}	Annual	50	0.0799
	24 hours	150	71.2
$PM_{2.5}$	3-year annual	15	(a)
	24 hours (98th percentile over 3 years)	65	(a)
Sulfur dioxide	Annual	80	0.0336
	24 hours	365	29.9
	3 hours	1,300	67.4

[a] No data is available with which to assess $PM_{2.5}$ concentrations.

Key: NAAQS, National Ambient Air Quality Standards.

Note: Based on 1994–1997 emissions data for diesel generators.

Source: Modeled concentrations based on DOE 1999f; EPA 1997a.

3.7.2.2 Waste Management

Table 3–77 presents the 5-year average annual waste generation rates for McGuire.

The waste disposal systems provide all equipment necessary to collect, process, store, and prepare for disposal of all radioactive liquid and solid wastes produced as a result of reactor operations. Potentially radioactive liquids may originate from a variety of sources, including the steam generator blowdown system, ventilation unit condensate system, drainage system sumps, laboratory drains, personnel decontamination area drains, decontamination system, sampling system, and laundry drains. Potentially radioactive liquid wastes are collected and characterized as to the level of contamination present. If contamination is below regulated levels, liquids may be discharged to the circulating water discharge outfall in accordance with the NPDES permit. If liquids are determined to be radioactively contaminated, they are treated by filtration, evaporation, or mixing and settling, or are sent to the demineralizers, before being discharged. Continuous radiation monitoring is provided for treated waste before its release to the circulating water discharge outfall. Liquid waste is analyzed and monitored to ensure that radionuclide concentrations are maintained as low as practical and well within the limits of applicable regulations and permits (Duke Power 1996:11-9–11-26).

Table 3–77. Annual Waste Generation for McGuire (m^3)

Waste Type	Generation Rate
LLW	42.2
Mixed LLW	0.19[a]
Hazardous waste	28.6[a]
Nonhazardous waste	
Liquid	49,740[b]
Solid	568[a]

[a] Values converted from kilograms assuming a waste density such that 1 m^3 = 1,000 kg.

[b] Assuming sanitary wastewater is generated at the same rate 365 days per year.

Key: LLW, low-level waste.

Source: DOE 1999f.

The radioactive solid waste disposal system provides facilities for holdup, packaging, and storage of wastes before shipment to offsite licensed treatment and disposal facilities. Radioactive solid waste may include evaporator concentrates, spent demineralizer resins, spent filters, laboratory wastes, contaminated oils, rags, gloves, boots, sweepings, brooms, and other miscellaneous tools and apparel that become contaminated during normal plant operations and maintenance. Treatment on the site may include dewatering, or solidification using a contractor-supplied mobile unit. Low-activity solid wastes, such as rags, clothing, and sweepings, are loaded directly into storage containers for shipment to an offsite treatment or disposal facility. Spent radioactive filter cartridges are packaged in drums or other waste containers, with spent resin solidified, if required. The disposal of slightly contaminated sludge from the wastewater treatment plant is carried out by landspreading the sludge on a site continguous to McGuire using a method approved by the State of North Carolina and NRC. Packaged wastes are stored in the filter storage bunker, solidified liner storage bunker, and the shielded storage bunker before being shipped to an offsite treatment or disposal facility (Duke Power 1996:11-49–11-56).

The small quantities of mixed LLW and hazardous waste generated are accumulated on the site before being shipped for commercial treatment and disposal in offsite permitted facilities. Nonhazardous solid wastes are generated by typical industrial processes and housekeeping activities and are collected on the site and managed off the site at the local permitted sanitary landfill. Nonhazardous sanitary wastewater is discharged to the Charlotte Mecklenburg Utility Department sanitary sewer system (Duke Power 1994).

3.7.2.3 Existing Human Health Risk

Major sources and levels of background radiation exposure to individuals within the vicinity of McGuire are shown in Table 3–78. Annual background radiation doses to individuals are expected to remain constant over time. Total dose to the population changes as population size changes. Background radiation doses are unrelated to reactor operations.

Releases of radionuclides to the environment from normal reactor operations provide another source of radiation exposure to populations within the vicinity of the site. The doses to the public resulting from these releases are shown in Table 3–79. These doses fall within regulatory limits and are small when compared with background exposure.

Using a risk estimator of 500 cancer deaths per 1 million person-rem (5×10^{-4} fatal cancer per person-rem) to the public (see Appendix F.10), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from normal reactor operations in 1997 is estimated to be 4.9×10^{-8}. That is, the estimated

Table 3–78. Sources of Radiation Exposure to Individuals in the McGuire Vicinity Unrelated to McGuire Operations

Source	Effective Dose Equivalent (mrem/yr)
Natural background radiation	
Cosmic and external and internal terrestrial radiation[a]	125
Radon in homes (inhaled)[b]	200[c]
Other background radiation[b]	
Diagnostic x rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	390

[a] Virginia Power 1998:11B-3.
[b] NCRP 1987:11, 40, 53.
[c] An average for the United States.

Table 3–79. Radiological Impacts on the Public From McGuire Operations in 1997 (Total Effective Dose Equivalent)

	Atmospheric Releases		Liquid Releases		Total	
Members of the Public	**Standard[a]**	**Actual**	**Standard[a]**	**Actual**	**Standard[a]**	**Actual**
Maximally exposed individual (mrem)	5	0.033	3	0.065	25	0.098
Population within 80 km (person-rem)[b]	NA	2.8	NA	93	NA	96

[a] The standards for individuals are given in 10 CFR 50, Appendix I. The standard for maximally exposed offsite individual (25 mrem/yr total body from all pathways) is given in 40 CFR 190.
[b] Population used: 2,140,720; this population dose was estimated for the year 2000 and is assumed to be representative for the year 1997.

Key: NA, not applicable.
Source: DOE 1999f; Duke Power 1974:5.3-7, table 5.3.5-1; 1996:table 2-1.

probability of this person dying from cancer from radiation exposure from 1 year of normal reactor operations is about 1 chance in 20 million.

According to the same risk estimator, 0.048 excess fatal cancer is projected among the population living within 80 km (50 mi) of McGuire in 1997. For perspective, this number can be compared with the number of fatal cancers expected in this population from all causes. The 1996 mortality rate associated with cancer for the entire population was 0.2 percent per year (Famighetti 1998:964). Based on this national rate, the number of fatal cancers from all causes expected during 1997 in the population living within 80 km (50 mi) of McGuire was about 4,300. This number of expected fatal cancers is much higher than the estimated 0.048 fatal cancer that could result from normal reactor operations in 1997.

Workers at the reactors receive the same background radiation dose as the general public; however, they receive an additional dose from normal operations of the reactors. Table 3–80 includes average, maximally exposed, and total occupational doses to reactor workers from operations in 1997. Based on a risk estimator of 400 cancer deaths per 1 million person-rem (4×10^{-4} fatal cancer per person-rem) among workers, the number of fatal cancers to reactor workers from 1997 normal operations is estimated to be 0.20.

Table 3–80. Radiological Impacts on Involved Workers From McGuire Operations in 1997

Number of badged workers[a]	3992
Total dose (person-rem/yr)	492
Annual latent fatal cancers	0.20
Average worker dose (mrem/yr)	123
Annual risk of latent fatal cancer	4.9×10^{-5}

[a] A badged worker is equipped with an individual dosimeter.
Note: The radiological limit for an individual worker is 5,000 mrem/yr (10 CFR 20). An effective ALARA program would ensure that doses are reduced to levels that are as low as is reasonably achievable.
Source: DOE 1999f.

3.7.2.4 Environmental Justice

Environmental justice concerns the environmental impacts that proposed actions may have on minority and low-income populations, and whether such impacts are disproportionately high and adverse (CEQ 1997). In the case of McGuire, the potentially affected area includes parts of North Carolina and South Carolina.

The potentially affected area around McGuire is defined by a circle with an 80-km (50-mi) radius centered at these reactors (lat. 35E25N590 N, long. 80E56N550 W). The total population residing within that area in 1990 was 1,738,966. The proportion of the population that was considered minority was 17.6 percent. The same census data show that the percentage of minorities for the contiguous United States was 24.1, and the percentages of the States of North and South Carolina were 25.0 and 31.5, respectively (DOC 1992).

At the time of the 1990 census, Blacks were the largest minority group within the potentially affected area, constituting 15.9 percent of the total population. Hispanics and Asians contributed about 0.7 percent, and Native Americans made up about 0.3 percent of the population (DOC 1992).

A breakdown of incomes in the potentially affected area is also available from the 1990 census data (DOC 1992). At that time, the poverty threshold was $9,981 for a family of three with one related child under 18 years of age. A total of 170,956 persons (9.8 percent of the total population) residing within the potentially affected area around McGuire reported incomes below that threshold. Data obtained during the 1990 census also show that of the total population of the contiguous United States, 13.1 percent reported incomes below the poverty threshold, and that the figures for North Carolina and South Carolina were 13.0 and 15.4 percent, respectively (DOC 1992).

3.7.3 North Anna Units 1 and 2 Site Overview

The North Anna nuclear power plant occupies 422 ha (1,043 acres) in Louisa County, Virginia, approximately 64.4 km (40 mi) north-northwest of Richmond, Virginia, and 113 km (70 mi) southwest of Washington, D.C. (see Figure 3–36). The largest community within 16 km (10 mi) of the site is the town of Mineral in Louisa County. The site is on a peninsula on the southern shore of Lake Anna. Lake Anna is approximately 27.4 km (17 mi) long, with a surface area of 5,260 ha (13,000 acres) and 322 km (200 mi) of shoreline. The reservoir contains approximately 380 billion l (100 billion gal) of water (Virginia Power 1998:2.1-1, 2.1-2).

In 1997, the plant employed 552 persons (DOE 1999f). The North Anna reactors are operated by the Virginia Power Company. The operating licenses (Nos. NPF–4 and NPF–7) for these reactors were granted in 1978 and 1980, and expire in 2018 and 2020, respectively (NRC 1997). It is estimated that the population within an 80-km (50-mi) radius of the reactor is 1,614,983 (Virginia Power 1998:2.1-21).

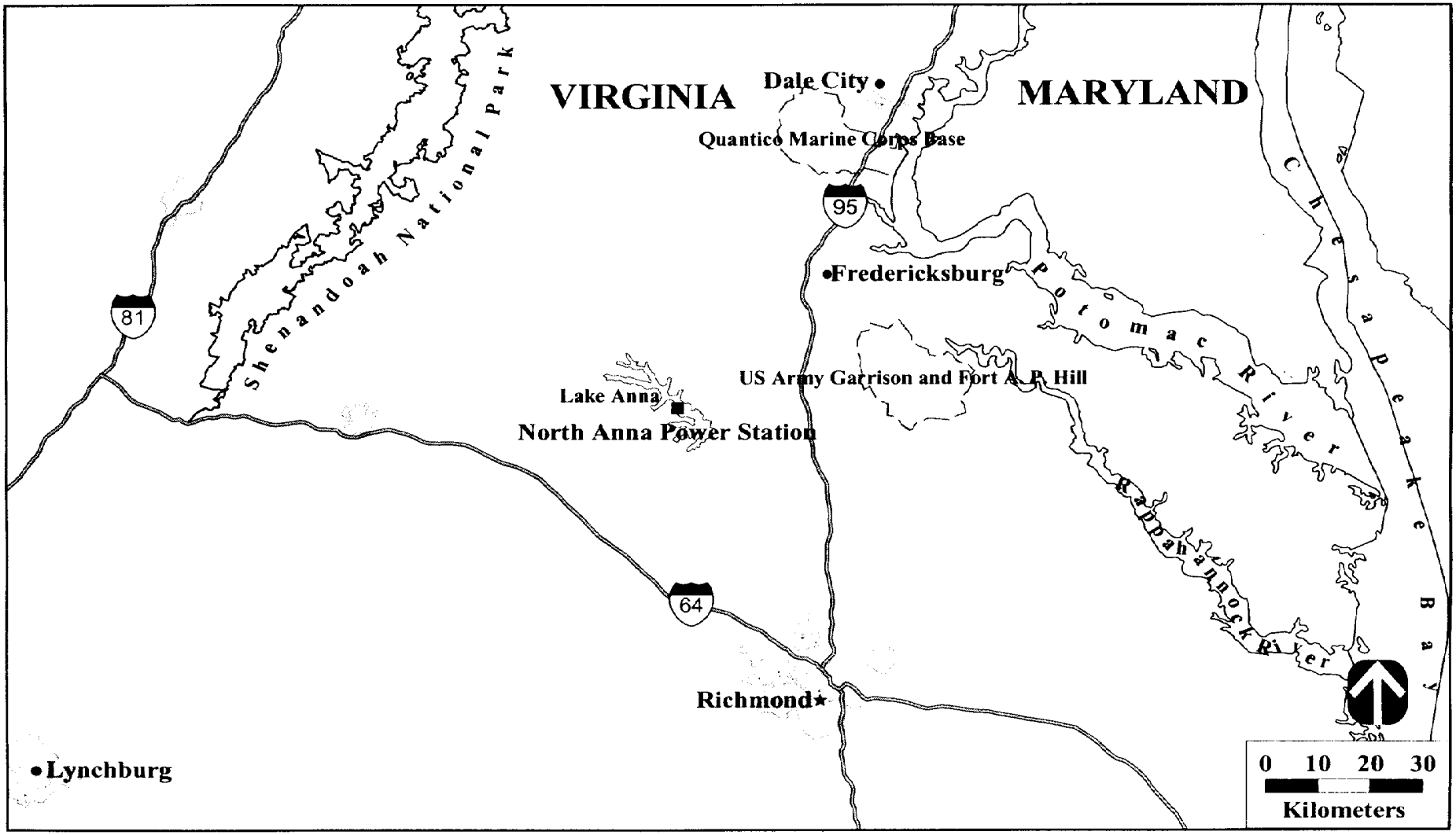


Figure 3–36. North Anna Nuclear Power Plant, Virginia

Reactor cooling is accomplished using a once-through cooling system with water obtained from Lake Anna (Virginia Power 1998:2.1-2). The rate of cooling water withdrawal is 5,564,000 million l/yr (1,470,000 million gal/yr), with all water returned to Lake Anna (DOE 1999f). There are no known industrial users downstream from the site until some 97 km (60 mi) downstream at West Point, where a large pulp and paper manufacturing plant is located. There are no known potable water withdrawals along the entire stretch of the river downstream to West Point, where the river becomes brackish (Virginia Power 1998:2.4-3).

New (unirradiated) fuel assemblies are dry stored in the new fuel storage area of the fuel building. The new fuel storage area has a capacity of 126 fuel assemblies. Spent (irradiated) fuel assemblies are stored under water in the spent fuel pit in the fuel building. The spent fuel storage pit has a capacity of 1,737 fuel assemblies (Virginia Power 1998:9.1-1, 9.1-2). Dry cask storage is being developed and is expected to have a capacity of an additional 1,824 assemblies (NRC 1998). Security at the site is provided in accordance with NRC regulations and includes security checkpoints, barbed wire fencing, surveillance cameras, and intruder detection. More information about these reactors can be found at the NRC Web site at http://www.nrc.gov/OPA/finder.htm (NRC 1999) and in NRC Docket Nos. 50–338 and 50–339.

3.7.3.1 Air Quality

North Anna is within the Northeastern Virginia AQCR #224. None of the areas within the site or Louisa County are designated as nonattainment areas with respect to the NAAQS for criteria air pollutants (EPA 1998f).

Sources of criteria air pollutants from North Anna include two auxiliary boilers, four emergency diesel generators, a station blackout generator, and miscellaneous equipment such as trucks and forklifts. Table 3–81 provides a summary of criteria pollutant concentrations from operations of North Anna. The concentrations resulting from operationsare well below the applicable ambient air quality standards even when background concentrations from other offsite sources are considered.

3.7.3.2 Waste Management

Table 3–82 presents the 5-year average annual waste generation rates for North Anna.

The waste disposal systems provide all equipment necessary to collect, process, store, and prepare for disposal of all radioactive liquid and solid wastes produced as a result of reactor operations. Potentially radioactive liquids may originate from a variety of sources, including the boron recovery system, steam generator blowdown system, drainage system sumps, laboratory drains, personnel decontamination area drains, decontamination system, sampling system, laundry drains, and spent resin flush system. Potentially radioactive liquid wastes are collected and characterized as to the level of contamination present. If contamination is below regulated levels, liquids may be discharged to the circulating water discharge outfall in accordance with the NPDES permit. If liquids are determined to be radioactively contaminated, they are treated by the ion exchange filtration system or demineralizers to reduce contamination before being discharged. Continuous radiation monitoring is provided for treated liquid waste before its release to the circulating water discharge outfall. Liquid waste is analyzed and monitored to ensure that radionuclide concentrations are maintained as low as practical and well within the limits of applicable regulations and permits (Virginia Power 1998:11.2-1, 11.2-2).

The radioactive solid waste disposal system provides facilities for holdup, packaging, and storage of wastes before shipment to offsite treatment and disposal facilities. Radioactive solid waste may include spent resin slurries, spent filter cartridges, rags, gloves, boots, brooms, and other miscellaneous tools and apparel that become contaminated during normal plant operations and maintenance. Contaminated solid materials resulting

Table 3–81. Comparison of Contribution to Nonradiological Ambient Air Pollutant Concentrations From North Anna Sources With National Ambient Air Quality Standards

Pollutant	Averaging Period	NAAQS (Fg/m^3)	North Anna (Fg/m^3)
Carbon monoxide	8 hours	10,000	416
	1 hour	40,000	594
Nitrogen dioxide	Annual	100	0.00504
PM_{10}	Annual	50	0.00407
	24 hours	150	15.4
$PM_{2.5}$	3-year annual	15	(a)
	24 hours (98th percentile over 3 years)	65	(a)
Sulfur dioxide	Annual	80	0.0167
	24 hours	365	63
	3 hours	1,300	142

[a] No data is available with which to assess $PM_{2.5}$ concentrations.

Key: NAAQS, National Ambient Air Quality Standards.

Note: Based on 1997 emissions data for diesel generators.

Source: Modeled concentrations based on DOE 1999f; EPA 1997a.

Table 3–82. Annual Waste Generation for North Anna (m^3)

Waste Type	Generation Rate
LLW	236.6[a]
Mixed LLW	0
Hazardous waste	11.4
Nonhazardous waste	
Liquid	681
Solid	10,400

[a] Two-year average (1996–1997).

Key: LLW, low-level waste.

Source: DOE 1999f.

from station maintenance are stored in specified areas of the auxiliary building and the decontamination building. Materials that are compressible are placed in 208-l (55-gal) drums for compaction at the bailing facility. Compressible materials and other contaminated solid materials that are not placed in drums are placed in 6.1-m (20-ft) seavans for shipment to offsite licensed treatment and disposal facilities. Contaminated metallic materials and highly contaminated solid objects are placed inside disposable containers for shipment to a disposal facility (Virginia Power 1998:11.5-1–11.5-3).

The small quantities of mixed LLW and hazardous waste generated are accumulated on the site before being shipped for commercial treatment and disposal in offsite permitted facilities. Nonhazardous solid wastes are generated by typical industrial processes and housekeeping activities and are collected on the site and managed off the site at the local permitted sanitary landfill. Nonhazardous sanitary wastewater is treated in the onsite sanitary wastewater treatment facility and then discharged to Lake Anna (VADEQ 1997:9, 28).

3.7.3.3 Existing Human Health Risk

Major sources and levels of background radiation exposure to individuals within the vicinity of North Anna are shown in Table 3–83. Annual background radiation doses to individuals are expected to remain constant over time. Total dose to the population changes as population size changes. Background radiation doses are unrelated to reactor operations.

Table 3–83. Sources of Radiation Exposure to Individuals in the North Anna Vicinity Unrelated to North Anna Operations

Source	Effective Dose Equivalent (mrem/yr)
Natural background radiation	
Cosmic and external and internal terrestrial radiation[a]	125
Radon in homes (inhaled)[b]	200[c]
Other background radiation[b]	
Diagnostic x rays and nuclear medicine	53
Weapons test fallout	<1
Air travel	1
Consumer and industrial products	10
Total	390

[a] Virginia Power 1998:11B-3.
[b] NCRP 1987:11, 40, 53.
[c] An average for the United States.

Releases of radionuclides to the environment from normal reactor operations provide another source of radiation exposure to populations within the vicinity of the site. The doses to the public resulting from these releases are shown in Table 3–84. These doses fall within regulatory limits and are small when compared with background exposure.

Table 3–84. Radiological Impacts on the Public From North Anna Operations in 1997 (Total Effective Dose Equivalent)

	Atmospheric Releases		Liquid Releases		Total	
Members of the Public	**Standard[a]**	**Actual**	**Standard[a]**	**Actual**	**Standard[a]**	**Actual**
Maximally exposed individual (mrem)	5	6.1×10^{-4}	3	0.28	25	0.28
Population within 80 km (person-rem)[b]	NA	6.0	NA	9.0	NA	15.0

[a] The standards for individuals are given in 10 CFR 50, Appendix I. The standard for the maximally exposed offsite individual (25 mrem/yr total body from all pathways) is given in 40 CFR 190.
[b] Population used: 1,614,983; this population dose was estimated for the year 2000 and is assumed to be representative for the year 1997. Population doses were ratioed to reflect latest census data projections.
Key: NA, not applicable.
Source: DOE 1999f; Virginia Power 1998:2.1-21, 11B-3, 11.3-13.

Using a risk estimator of 500 cancer deaths per 1 million person-rem (5×10^{-4} fatal cancer per person-rem) to the public (see Appendix F.10), the fatal cancer risk to the maximally exposed member of the public due to radiological releases from normal reactor operations in 1997 is estimated to be 1.4×10^{-7}. That is, the estimated probability of this person dying from cancer from radiation exposure from 1 year of normal reactor operations is about one chance in seven million.

According to the same risk estimator, 0.0075 excess fatal cancer is projected among the population living within 80 km (50 mi) of North Anna in 1997. For perspective, this number can be compared with the number of fatal cancers expected in this population from all causes. The 1996 mortality rate associated with cancer for the entire population was 0.2 percent per year (Famighetti 1998:964). Based on this national rate, the number of fatal cancers from all causes expected during 1997 in the population living within 80 km (50 mi) of North Anna was about 3,200. This number of expected fatal cancers is much higher than the estimated 0.0075 fatal cancer that could result from normal reactor operations in 1997.

Workers at the reactors receive the same background radiation dose as the general public, however, they receive an additional dose from normal operations of the reactors. Table 3–85 includes average, maximally exposed, and total occupational doses to reactor workers from operations in 1997. Based on a risk estimator of 400 cancer deaths per 1 million person-rem (4×10^{-4} fatal cancer per person-rem) among workers, the number of fatal cancers to reactor workers from 1997 normal operations is estimated to be 0.041.

Table 3–85. Radiological Impacts on Involved Workers From North Anna Operations in 1997

Number of badged workers[a]	2,243
Total dose (person-rem/yr)	103
Annual latent fatal cancers	0.041
Average worker dose (mrem/yr)	46
Annual risk of latent fatal cancer	1.8×10^{-5}

[a] A badged worker is equipped with an individual dosimeter.

Note: The radiological limit for an individual worker is 5,000 mrem/yr (10 CFR 20). An effective ALARA program would ensure that doses are reduced to levels that are as low as is reasonably achievable.

Source: DOE 1999f.

3.7.3.4 Environmental Justice

Environmental justice concerns the environmental impacts that proposed actions may have on minority and low-income populations, and whether such impacts are disproportionately high and adverse (CEQ 1997). In the case of North Anna, the potentially affected area includes parts of Maryland and Virginia.

The potentially affected area around North Anna is defined by a circle with an 80-km (50-mi) radius centered around these reactors (lat. 38E03N370 N, long. 77E47N240 W). The total population residing within that area in 1990 was 1,286,156. The proportion of the population that was considered minority was 21.9 percent. The same census data show that the percentages of minorities for the contiguous United States was 24.1, and the percentage of the States of Maryland and Virginia were 30.4 and 24.0, respectively (DOC 1992).

At the time of the 1990 census, Blacks were the largest minority group within the potentially affected area, constituting 18.8 percent of the total population. Asians contributed about 1.5 percent, and Hispanics, about 1.4 percent. Native Americans made up about 0.3 percent of the population (DOC 1992).

A breakdown of incomes in the potentially affected area is also available from the 1990 census data (DOC 1992). At that time, the poverty threshold was $9,981 for a family of three with one related child under 18 years of age. A total of 88,162 persons (6.9 percent of the total population) residing within the potentially affected area around North Anna reported incomes below that threshold. Data obtained during the 1990 census also show that of the total population of the contiguous United States, 13.1 percent reported incomes below the poverty threshold, and that the figures for Maryland and Virginia were 8.3 and 10.3 percent, respectively (DOC 1992).

3.8 REFERENCES

Abbott, D.G., 1998, Lockheed Martin Idaho Technologies Company, Idaho Falls, ID, personal communication to J. DiMarzio, Science Applications International Corporation, Germantown, MD, *SPD EIS - Additional Questions on Affected Environment*, January 28.

Abbott, D.G., A.B. Crockett, and K.S. Moor, 1997, *INEEL Affected Environment: Supplemental Data Report in Support of the Preparation of the Surplus Plutonium Disposition Environmental Impact Statement (Predecisional Draft)*, INEL/EXT-97-00563, Lockheed Martin Idaho Technologies Company, Idaho Falls, ID, June.

Abbott, M.L., J.M. Brooks, and K.L. Martin, 1991, *NPR Environmental Impact at the INEL: Air Quality, Cooling Towers, and Noise*, rev. A, NPRD-90-059, EG&G Idaho, Inc., Idaho Falls, ID, March.

Aragon, K., 1999, U.S. Department of Energy, Carlsbad Area Office, Carlsbad, NM, personal communication (facsimile) to J. DiMarzio, Science Applications International Corporation, Germantown, MD, *Schedule for TRU Waste Shipments Sent from Generator Sites*, February 4.

Arnett, M.W., and A.R. Mamatey, eds., 1996, *Savannah River Site Environmental Report for 1995*, WSRC-TR-96-0075, Westinghouse Savannah River Company, Aiken, SC.

Arnett, M.W., and A.R. Mamatey, eds., 1997a, *Savannah River Site Environmental Report for 1996*, WSRC-TR-97-0171, Westinghouse Savannah River Company, Aiken, SC.

Arnett, M.W., and A.R. Mamatey, eds., 1997b, *Savannah River Site Environmental Data for 1996*, WSRC-TR-97-0077, Westinghouse Savannah River Company, Aiken, SC.

Arnett, M.W., L.K. Karapatakis, and A.R. Mamatey, eds., 1993, *Savannah River Site Environmental Report for 1992*, WSRC-TR-93-075, Westinghouse Savannah River Company, Aiken, SC.

Arnett, M.W., L.K. Karapatakis, and A.R. Mamatey, eds., 1994, *Savannah River Site Environmental Report for 1993*, WSRC-TR-94-075, Westinghouse Savannah River Company, Aiken, SC.

Bala, E., 1997, Idaho Transportation Department, Rigby, ID, personal communication to D.M. Nemeth, Science Applications International Corporation, Germantown, MD, *Transportation Improvements in Idaho*, September 11.

Barghusen, J., and R. Feit, 1995, *Technical Report on Affected Environment for the DOE Sites Considered in the DOE Waste Management Programmatic Environmental Impact Statement*, META/Berger-SR-01, META/Berger, Gaithersburg, MD, July.

Battelle (Battelle Memorial Institute), 1989, *Hanford Cultural Resources Management Plan*, PNL-6942, Pacific Northwest National Laboratory, Richland, WA, June.

Battelle and M&H (Battelle Pantex and Mason & Hanger Corporation), 1996, *Biological Assessment of Continued Operation of Pantex Plant and Associated Storage of Nuclear Weapon Components*, Amarillo, TX, April 26.

Battley, V.L., 1999, U.S. Department of Energy, Amarillo Area Office, Amarillo, TX, personal communication (facsimile) to K. Folk, Science Applications International Corporation, Germantown, MD, *Signed FFCA for Pantex*, January 25.

Berenbrock, C., and L.C. Kjelstrom, 1998, *Preliminary Water-Surface Elevations and Boundaries of the 100-Year Peak Flow in the Big Lost River at the Idaho National Engineering and Environmental Laboratory, Idaho,* Water-Resources Investigations Report 98-4065, U.S. Geological Survey, Boise, ID.

Cabak, M.A, K.E. Sassaman, and J.C. Gillam, 1996, "Distributional Archaeology in the Aiken Plateau: Intensive Survey of E Area, Savannah River Site, Aiken County, South Carolina," *Savannah River Archaeological Research Papers 8, Occasional Papers of the Savannah River Archaeological Research Program*, South Carolina Institute of Archaeology and Anthropology, University of South Carolina, Aiken, SC.

CEQ (Council on Environmental Quality), 1986, *Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act*, "Human Environment," 40 CFR 1508.14, Washington, DC, July 1.

CEQ (Council on Environmental Quality), 1997, *Environmental Justice, Guidance Under the National Environmental Policy Act,* Executive Office of the President, Washington, DC, December 10.

Clawson, K.L., G.E. Start, and N.R. Ricks, eds., 1989, *Climatography of the Idaho National Engineering Laboratory,* 2nd ed., DOE/ID-12118, U.S. Department of Energy, Idaho Operations Office, Idaho Falls, ID, December.

Depperschmidt, J., 1999, U.S. Department of Energy, Idaho Operations Office, Idaho Falls, ID, personal communication (fax) to S. Lesica, U.S. Department of Energy, Office of Nuclear Facilities Management, Germantown, MD, *Comments from DOE-ID HLW Program Office*, June 29.

Dirkes, R.L., and R.W. Hanf, eds., 1996, *Hanford Site 1995 Environmental Report*, PNNL-11139, Battelle, Pacific Northwest National Laboratory, Richland, WA, June.

Dirkes, R.L., and R.W. Hanf, eds., 1997, *Hanford Site 1996 Environmental Report*, PNNL-11472, Battelle, Pacific Northwest National Laboratory, Richland, WA, August.

DOC (U.S. Department of Commerce), 1990a, *1990 Census Look Up,* Summary Tape File 1C, Bureau of the Census, Washington, DC.

DOC (U.S. Department of Commerce), 1990b, *1990 EEO File: Detailed Occupations by Sex by Hispanic Origin and Race,* Bureau of the Census, Housing and Household Economic Statistics Division, Washington, DC.

DOC (U.S. Department of Commerce), 1992, *Census of Population and Housing, 1990: Summary Tape File 3 on CD-ROM*, Bureau of the Census, May.

DOC (U.S. Department of Commerce), 1994, *County and City Data Book: 1994, Washington, DC,* Bureau of the Census, Washington, DC, 1994.

DOC (U.S. Department of Commerce), 1996, *Statistical Abstract of the United States: 1996,* 116th Edition, Bureau of the Census, Washington, DC, October.

DOC (U.S. Department of Commerce), 1997, *Estimates of the Population of Counties and Demographic Components of Population Change: Annual Time Series, July 1, 1990 to July 1, 1996,* www.census.gov/population/estimates/county/CO-96-08, Bureau of the Census, Population Estimates Program, Population Division, Washington, DC.

DOE (U.S. Department of Energy), 1983, *Final Environmental Impact Statement Pantex Plant Site, Amarillo, Texas*, DOE/EIS-0098, Washington, DC, October.

DOE (U.S. Department of Energy), 1992, *Final Environmental Impact Statement and Environmental Impact Report for Continued Operation of Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore*, DOE/EIS-0157, San Francisco Field Office, Oakland, CA, August.

DOE (U.S. Department of Energy), 1993a, *Radiation Protection of the Public and the Environment*, DOE Order 5400.5, Office of Environment, Safety and Health, January 7.

DOE (U.S. Department of Energy), 1993b, *Radiation Protection of the Public and the Environment*, proposed rule 10 CFR 834, 58 FR 16268, Office of the Federal Register, Washington, DC, March 23.

DOE (U.S. Department of Energy), 1994a, *Radiological Control Manual*, rev. 1, DOE/EH-0256T, Office of Environment, Safety and Health, Washington, DC, April.

DOE (U.S. Department of Energy), 1994b, *Memorandum of Agreement Between the United States Department of Energy Idaho Operations Office and the Shoshone-Bannock Tribes*, OID-OC-RAK-94-11, Idaho Operations Office, Idaho Falls, ID, February 2.

DOE (U.S. Department of Energy), 1994c, *Final Supplemental Environmental Impact Statement, Defense Waste Processing Facility*, DOE/EIS-0082-S, Savannah River Operations Office, Aiken, SC, November.

DOE (U.S. Department of Energy), 1995a, *Occupational Radiation Protection*, 10 CFR 835, Washington, DC, January 1.

DOE (U.S. Department of Energy), 1995b, *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, Office of Environmental Management, Idaho Operations Office, Idaho Falls, ID, April.

DOE (U.S. Department of Energy), 1995c, *Savannah River Site Waste Management Final Environmental Impact Statement*, DOE/EIS-0217, Savannah River Operations Office, Aiken, SC, July.

DOE (U.S. Department of Energy), 1996a, *Storage and Disposition of Weapons-Usable Fissile Materials Final Programmatic Environmental Impact Statement*, DOE/EIS-0229, Office of Fissile Materials Disposition, Washington, DC, December.

DOE (U.S. Department of Energy), 1996b, *Draft Hanford Remedial Action Environmental Impact Statement and Comprehensive Land Use Plan*, DOE/EIS-0222D, Richland Operations Office, Richland, WA, August.

DOE (U.S. Department of Energy), 1996c, *Tank Waste Remediation System, Hanford Site, Richland, Washington, Final Environmental Impact Statement*, DOE/EIS-0189, Richland Operations Office, Richland, WA, August.

DOE (U.S. Department of Energy), 1996d, *Integrated Data Base Report - 1995: U.S. Spent Nuclear Fuel and Radioactive Waste Inventories, Projections, and Characteristics*, rev. 12, DOE/RW-0006, Office of Environmental Management, Germantown, MD, December.

DOE (U.S. Department of Energy), 1996e, *Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Policy Concerning Foreign Research Reactor Spent Nuclear Fuel*, DOE/EIS-0218F, Office of Environmental Management, Washington, DC, February.

DOE (U.S. Department of Energy), 1996f, *Final Environmental Impact Statement for the Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components*, DOE/EIS-0225, Albuquerque Operations Office, Albuquerque, NM, November.

DOE (U.S. Department of Energy), 1996g, *Programmatic Agreement Among the U.S. Department of Energy/Amarillo Area Office, the Texas State Historic Preservation Officer, and the Advisory Council on Historic Preservation*, Amarillo Area Office, Amarillo, TX, October.

DOE (U.S. Department of Energy), 1996h, *The 1996 Baseline Environmental Management Report*, DOE/EM-0290, Office of Environmental Management, Washington, DC, June.

DOE (U.S. Department of Energy), 1996i, *Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management*, DOE/EIS-0236, Office of Fissile Materials Disposition, Washington, DC, September.

[Text deleted.]

DOE (U.S. Department of Energy), 1997a, *Final Waste Management Programmatic Environmental Impact Statement for Managing Treatment, Storage, and Disposal of Radioactive and Hazardous Waste*, DOE/EIS-0200-F, Office of Environmental Management, Washington, DC, May.

DOE (U.S. Department of Energy), 1997b, *Idaho National Engineering and Environmental Laboratory, Comprehensive Facility and Land Use Plan*, DOE/ID-10514, Idaho Operations Office, Idaho Falls, ID, April 30.

DOE (U.S. Department of Energy), 1997c, *1996 Environmental Report for Pantex Plant*, DOE/AL/65030-9704, Albuquerque Operations Office, Amarillo Area Office, Amarillo, TX, May.

DOE (U.S. Department of Energy), 1997d, *Waste Isolation Pilot Plant Disposal Phase Final Supplemental Environmental Impact Statement*, DOE/EIS-0026-S-2, Carlsbad Area Office, Carlsbad, NM, September.

DOE (U.S. Department of Energy), 1997e, *Shutdown of the River Water System at the Savannah River Site Final Environmental Impact Statement*, DOE/EIS-0268, Savannah River Operations Office, Aiken, SC, May.

DOE (U.S. Department of Energy), 1997f, *Accelerator for Production of Tritium at the Savannah River Site Environmental Impact Statement*, DOE/EIS-0270D, Savannah River Operations Office, Aiken, SC, December.

DOE (U.S. Department of Energy), 1997g, *Site Profile, Los Alamos National Laboratory*, Office of Oversight, Environment, Safety and Health, Washington, DC, October.

DOE (U.S. Department of Energy), 1998a, *Record of Decision for the Department of Energy's Waste Management Program: Treatment and Storage of Transuranic Waste*, 63 FR 3629, Office of the Federal Register, Washington, DC, January 23.

DOE (U.S. Department of Energy), 1998b, *Record of Decision for the Department of Energy's Waste Management Program: Treatment of Nonwastewater Hazardous Waste*, 63 FR 41810, Office of the Federal Register, Washington, DC, August 5.

DOE (U.S. Department of Energy), 1998c, *Environmental Assessment for the Transfer of 1100 Area, Sourthern Rail Connection and Rolling Stock, Hanford Site, Richland, Washington*, DOE/EA-1260, Richland Operations Office, Richland, WA, August.

DOE (U.S. Department of Energy), 1998d, *Accelerating Cleanup, Paths to Closure*, DOE/EM-0362, Office of Environmental Management, Washington, DC, June.

DOE (U.S. Department of Energy), 1998e, *Draft Environmental Impact Statement for the Construction and Operation of a Tritium Extraction Facility at the Savannah River Site*, DOE/EIS-0271D, Savannah River Operations Office, Aiken, SC, May.

DOE (U.S. Department of Energy), 1998f, *Savannah River Site Spent Nuclear Fuel Management Draft Environmental Impact Statement*, DOE/EIS-0279D, Savannah River Operations Office, Aiken, SC, December.

DOE (U.S. Department of Energy), 1998g, *Final Environmental Impact Statement on Management of Certain Plutonium Residues and Scrub Alloy Stored at the Rocky Flats Environmental Technology Site*, DOE/EIS-0277F, Office of Environmental Management, Washington, DC, August.

DOE (U.S. Department of Energy), 1999a, *Semi-Annual Progress Report, NPDES Permit No. TX0107107*, Federal Facilities Compliance Agreement (FFCA) Docket No. VI-98-1210, Administrative Order (AO) Docket No. VI-98-0401, Amarillo Area Office, Amarillo, TX, January 12.

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

DOE (U.S. Department of Energy), 1999c, *INEEL Shipment Arrives Safely at Waste Isolation Pilot Plant*, Press Release, Idaho Operations Office, Idaho Falls, ID, April 28.

DOE (U.S. Department of Energy), 1999d, *Final Environmental Assessment for Wastewater Treatment Capability Upgrade*, DOE/EA-1190, Amarillo Area Office, Amarillo, TX, April.

DOE (U.S. Department of Energy), 1999e, *Finding of No Significant Impact, Wastewater Treatment Facility Upgrade, Pantex Plant*, May 27.

DOE (U.S. Department of Energy), 1999f, *MOX Fuel Fabrication Facility and Nuclear Power Reactor Data Report*, MD-0015, Office of Fissile Materials Disposition, Washington, DC, August.

DOE (U.S. Department of Energy), 1999g, *Final Environmental Impact Statement, Construction and Operation of the Spallation Neutron Source*, DOE/EIS-0247, Office of Science, Germantown, MD, April.

DOE (U.S. Department of Energy), 1999h, *REMS Query Results for Oak Ridge for 1997*, rems.eh.doe.gov/rems/, Office of Environment, Safety and Health Web site.

DOI (U.S. Department of the Interior), 1986a, *Visual Resource Inventory, BLM Manual Handbook H-8410-1*, Bureau of Land Management, Washington, DC, January 17.

DOI (U.S. Department of the Interior), 1986b, *Visual Resource Contrast Rating, BLM Manual Handbook H-8431-1*, Bureau of Land Management, Washington, DC, January 17.

DOL (U.S. Department of Labor), 1997, *Employment and Wages, Annual Averages, 1995*, Bureau of Labor Statistics, Office of Employment and Unemployment Statistics, Washington, DC.

DOL (U.S. Department of Labor), 1999, *Local Area Unemployment Statistics for Year 1996*, www.bls.gov/sahome.html, Bureau of Labor Statistics, Office of Employment and Unemployment Statistics, Local Area Unemployment Statistics Division, Washington, DC, April 8.

DOT (U.S. Department of Transportation), 1995, *Airport Noise Compatibility Planning*, 14 CFR 150, July 18.

Duke Power (Duke Power Company), 1974, *McGuire Environmental Report, Operating Stage*, Docket No. 50369-58, Atomic Energy Commission, Washington, DC.

Duke Power (Duke Power Company), 1994, *NPDES Permit Renewal, NC0024392, McGuire Nuclear Station, Mecklenburg County*, letter from J. Carter (Technical Systems Manager, GSD/Environmental Division) to C. Sullins (North Carolina Department of Environment, Health and Natural Resources), Huntersville, NC, June 30.

Duke Power (Duke Power Company), 1996, *McGuire Nuclear Station Updated Final Safety Analysis Report*, Charlotte, NC, May 14.

Duke Power (Duke Power Company), 1997, *Catawba Nuclear Station Updated Final Safety Analysis Report*, Charlotte, NC, May 2.

Dutton, A.R., and W.W. Simpkins, 1986, *Hydrogeochemistry and Water Resources of the Triassic Lower Dockum Group in the Texas Panhandle and Eastern New Mexico*, Report of Investigations No. 161, Bureau of Economic Geology, Austin, TX.

EPA (U.S. Environmental Protection Agency), 1974, *Information on Levels of Environmental Noise Requisite To Protect Public Health and Welfare With an Adequate Margin of Safety*, EPA/550/9-74-004, Office of Noise Abatement and Control, Washington, DC, March.

[Text deleted.]

EPA (U.S. Environmental Protection Agency), 1997a, *National Primary and Secondary Ambient Air Quality Standards*, 40 CFR 50, March 31.

EPA (U.S. Environmental Protection Agency), 1997b, *National Ambient Air Quality Standards for Ozone*, 62 FR 38855, Office of the Federal Register, Washington, DC, July 18.

EPA (U.S. Environmental Protection Agency), 1997c, *National Ambient Air Quality Standards for Particulate Matter*, 62 FR 38652, Office of the Federal Register, Washington, DC, July 18.

EPA (U.S. Environmental Protection Agency), 1997d, *Designation of Areas for Air Quality Planning Purposes*, "Idaho," 40 CFR 81.313, March 31.

EPA (U.S. Environmental Protection Agency), 1997e, *Designation of Areas for Air Quality Planning Purposes*, "Texas," 40 CFR 81.344, March 31.

EPA (U.S. Environmental Protection Agency), 1997f, *Designation of Areas for Air Quality Planning Purposes*, "Georgia," 40 CFR 81.311, March 31.

EPA (U.S. Environmental Protection Agency), 1997g, *Designation of Areas for Air Quality Planning Purposes*, "South Carolina," 40 CFR 81.341, March 31.

EPA (U.S. Environmental Protection Agency), 1997h, *Designation of Areas for Air Quality Planning Purposes,* "New Mexico," 40 CFR 81.332, March 31.

EPA (U.S. Environmental Protection Agency), 1998a, *State Program Requirements; Approval of Application to Administer the National Pollutant Discharge Elimination System (NPDES) Program; Texas,* 63 FR 51164, Office of the Federal Register, Washington, DC, September 24.

EPA (U.S. Environmental Protection Agency), 1998b, *Designation of Areas for Air Quality Planning Purposes,* "California," 40 CFR 81.305, July 1.

EPA (U.S. Environmental Protection Agency), 1998c, *Designation of Areas for Air Quality Planning Purposes, State of California: Redesignation of the San Francisco Bay Area to Nonattainment for Ozone,* final rule, 63 FR 37258, Office of the Federal Register, Washington, DC, July 10.

EPA (U.S. Environmental Protection Agency), 1998d, *Designation of Areas for Air Quality Planning Purposes,* "South Carolina," 40 CFR 81.341, July 1.

EPA (U.S. Environmental Protection Agency), 1998e, *Designation of Areas for Air Quality Planning Purposes,* "North Carolina," 40 CFR 81.334, July 1.

EPA (U.S. Environmental Protection Agency), 1998f, *Designation of Areas for Air Quality Planning Purposes,* "Virginia," 40 CFR 81.347, July 1.

ERDA (U.S. Energy Research Development Administration), 1976, *Evaluation of Impact of Potential Flooding Criteria on the Hanford Project,* RLO-76-4, Richland Operations Office, Richland, WA.

EuDaly, E.M., 1998, U.S. Department of the Interior, Fish and Wildlife Service, Charleston, SC, personal communication to M. Jones, U.S. Department of Energy, Office of Fissile Materials Disposition, Washington, DC, FWS Log No. 4-6-98-364, *Surplus Plutonium Disposition, Savannah River Site (SRS), Aiken County, South Carolina,* September 8.

Famighetti, R., ed., 1998, *The World Almanac and Book of Facts 1998,* K-III Reference Corporation, Mahwah, NJ.

Greenly, G.D., 1999, Waste and Environmental Management Department, DOE Pantex Plant, Amarillo, TX, personal communication to K. Folk, Science Applications International Corporation, Germantown, MD, *Buildings/Towers on the Pantex Plant Site,* June 18.

Gustavson, T.C., 1996, *Fluvial and Eolian Depositional Systems, Paleosols, and Paleoclimate of the Upper Cenozoic Ogallala and Blackwater Draw Formations, Southern High Plains, Texas and New Mexico,* Report of Investigations No. 239, Bureau of Economic Geology, Austin, TX.

Hamilton, L.V., et al., 1998, *Oak Ridge Reservation Annual Site Environmental Report for 1997,* ES/ESH-78, Oak Ridge National Laboratory, Oak Ridge, TN, October.

Harrach, R.J., et al., 1997, *Environmental Report 1996, Lawrence Livermore National Laboratory,* UCRL-50027-26, Lawrence Livermore National Laboratory, Livermore, CA, September 1.

Hartman, M.J., and P.F. Dresel, eds., 1997, *Hanford Site Groundwater Monitoring for Fiscal Year 1996,* PNNL-11470, Battelle, Pacific Northwest National Laboratory, Richland, WA, February.

Hoitink, D.J., and K.W. Burk, 1996, *Hanford Site Climatological Data Summary 1995 With Historical Data*, PNNL-11107, Battelle, Richland, WA, May.

ID DHW (Idaho Department of Health and Welfare), 1995, *Rules for the Control of Air Pollution in Idaho:* 577, "Ambient Standards for Specific Air Pollutants"; 585, "Toxic Air Pollutants Non-Carcinogenic Increments"; 586, "Toxic Air Pollutants Carcinogenic Increments," IDAPA 16, Title 01, Chapter 01, Boise, ID.

Jackson, S.M., 1985, "Acceleration Data from the 1983 Borah Peak, Idaho, Earthquake Recorded at the Idaho National Engineering Laboratory," in *Proceedings of Workshop XXVIII on the Borah Peak, Idaho, Earthquake*, R.S. Stein and R.C. Bucknam (eds.), Open-File Report 85-290, U.S. Geological Survey, Idaho Falls, ID, pp. 385-400.

Jones, M., 1999, U.S. Department of Energy, Washington, DC, personal communication (electronic mail) to J. DiMarzio and J. Eichner, Science Applications International Corporation, Germantown, MD, *Pantex Comments*, January 27.

Kielusiak, C., 1998a, Lawrence Livermore National Laboratory, Livermore, CA, personal communication to J. DiMarzio, Science Applications International Corporation, Germantown, MD, *Additional Waste Treatment Information*, April 21.

Kielusiak, C., 1998b, Lawrence Livermore National Laboratory, Livermore, CA, personal communication to J. DiMarzio, Science Applications International Corporation, Germantown, MD, *Revised Table 3.7.3.3-2*, Apri 23.

King, H.H., 1997a, Mason & Hanger Corporation, Amarillo, TX, personal communication (electronic mail) to J. DiMarzio, Science Applications International Corporation, Germantown, MD, *Additional Information for Pantex AE Data Call*, August 1.

King, H.H., 1997b, Mason & Hanger Corporation, Amarillo, TX, personal communication to J. DiMarzio, Science Applications International Corporation, Germantown, MD, *Waste Management Information for Pantex*, October 21.

Knox, J., 1997, U.S. Department of Energy, Savannah River Operations Office, personal communication (facsimile) to K. Gandee, U.S. Department of Energy, Office of Fissile Materials Disposition, Washington, DC, July 2.

Kovacs, J., 1997, B&W Hanford Company, Richland, WA, personal communication to J. DiMarzio, Science Applications International Corporation, Germantown, MD, *Waste Management Facilities at the Hanford Site*, October 23.

LANL (Los Alamos National Laboratory), 1998, *Environmental Surveillance at Los Alamos During 1997*, LA-13487-ENV, Los Alamos, NM.

Lemming, J.F., 1998, Mason & Hanger Corporation, Amarillo, TX, personal communication to J. DiMarzio, Science Applications International Corporation, Germantown, MD, *SPD EIS - Additional Questions on Affected Environment*, January 30.

Lyon, M., 1997, Battelle, Pacific Northwest National Laboratory, personal communication to J. Teal, Science Applications International Corporation, Richland, WA, *Hanford Calendar Year Manrem Data for 1996, 1995, and 1994*, April 30.

M&H (Mason & Hanger Corporation), 1996a, *Environmental Information Document: The Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components Environmental Impact Statement*, ES:96:0156, Amarillo, TX, September.

M&H (Mason & Hanger Corporation), 1996b, *Safety Information Document: The Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components Environmental Impact Statement*, ES:96:0155, Amarillo, TX, September.

M&H (Mason & Hanger Corporation), 1996c, *Integrated Plan for Playa Management at Pantex Plant*, Environmental Protection Department, Environmental, Safety and Health, Pantex Plant, Amarillo, TX, December.

M&H (Mason & Hanger Corporation), 1997, *Pantex Plant Affected Environment Data Report for the Surplus Plutonium Disposition Environmental Impact Statement*, Amarillo, TX, June 12.

MacNeil, R., 1997, Washington Department of Transportation, Union Gap, WA, personal communication to D.M. Nemeth, Science Applications International Corporation, Germantown, MD, *Transportation Improvements in Washington*, September 9.

Mayer, J.J., and L.D. Wike, 1997, *SRS Urban Wildlife: Environmental Information Document*, WSRC-TR-97-0093, Westinghouse Savannah River Company, Aiken, SC, May.

McConnaughey, J., 1998, State of Washington Department of the Fish and Wildlife, Department of Ecology, Kennewick, WA, personal communication to M. Jones, U.S. Department of Energy, Office of Fissile Materials Disposition, Washington, DC, *Comments on the Surplus Plutonium Disposition Draft Environmental Impact Statement, July 1998, DOE/EIS-0283-D*, December 7.

Mecca, J.E., 1997a, U.S. Department of Energy, Richland Operations Office, Richland, WA, personal communication to K.R. Gandee, U.S. Department of Energy, Office of Fissile Materials Disposition, Washington, DC, *Hanford Site Response to Site Environmental Data Call for Preparation of the Draft Surplus Plutonium Disposition Environmental Impact Statement*, June 11.

Mecca, J.E., 1997b, U.S. Department of Energy, Richland Operations Office, Richland, WA, personal communication to K.R. Gandee, U.S. Department of Energy, Office of Fissile Materials Disposition, Washington, DC, *Affected Environment Data Reports for the Surplus Plutonium Disposition EIS*, July 31.

Miles, M., 1998, U.S Department of Energy, Savannah River Operations Office, Aiken, SC, personal communication to J. DiMarzio, Science Applications International Corporation, Germantown, MD, *Volume Capacities for SRS*, May 28.

Miller, S., 1995, *Idaho National Engineering Laboratory Management Plan for Cultural Resources (Final Draft)*, rev. 1, DOE/ID-10361, Lockheed Martin Idaho Technologies Company, Idaho Falls, ID, July.

Mitchell, R.G., D. Peterson, and D.L. Hoff, 1996, *Idaho National Engineering Laboratory Site Environmental Report for Calendar Year 1995*, DOE/ID-12082(95), U.S. Department of Energy, Idaho Operations Office, Idaho Falls, ID, August.

Mitchell, R.G., D. Peterson, D. Roush, R.W. Brooks, L.R. Paulus, and D.B. Martin, 1997, *Idaho National Engineering Laboratory Site Environmental Report for Calendar Year 1996*, DOE/ID-12082(96), U.S. Department of Energy, Idaho Operations Office, Idaho Falls, ID, August.

Moor, K., 1998, Lockheed Martin Idaho Technologies Company, Idaho Falls, ID, personal communication to J. DiMarzio, Science Applications International Corporation, Germantown, MD, *Waste Management Facilities at the Idaho National Engineering and Environmental Laboratory*, January.

Nava, B., 1998, Battelle-Pantex, Amarillo, TX, personal communication to J. DiMarzio, Science Applications International Corporation, Germantown, MD, *Administrative Order for Pantex*, May 28.

NCRP (National Council on Radiation Protection and Measurements), 1987, *Ionizing Radiation Exposure of the Population of the United States*, NCRP Report No. 93, Pergamon Press, Elmsford, NY, September 1.

Neitzel, D.A., ed., 1996, *Hanford Site National Environmental Policy Act (NEPA) Characterization*, rev. 8, PNL-6415, Battelle, Pacific Northwest National Laboratory, Richland, WA, August.

Nemeth, D.M., 1997a, *List of School Districts Contacted for Current Operating Capacities, Student Enrollment, and Number of Teachers Employed Within the Hanford, INEEL, Pantex, and SRS ROIs*, Memorandum to SPD EIS Administrative Record, December 15.

Nemeth, D.M., 1997b, *List of Sheriff Offices, Police Departments, and Fire Departments Contacted for Number of Sworn Police Officers Employed and Firefighters (Both Employed and Volunteer) in the Hanford, INEEL, Pantex, and SRS ROIs*, Memorandum to SPD EIS Administrative Record, December 15.

Nemeth, D.M., 1997c, *List of Hospitals and Hospital Associations Contacted for Current Number of Hospitals and Hospital Beds Located in Hanford, INEEL, Pantex, and SRS ROIs*, Memorandum to SPD EIS Administrative Record, December 17.

Nesbit, S., 1999, Duke Energy, Charlotte, NC, personal communication to P. Wherley, Science Applications International Corporation, Germantown, MD, *Duke Power Comments on the April 1999 Supplement to the SPD Draft EIS*, June 21.

Nipp, B., 1997, Texas Department of Transportation, Amarillo, TX, personal communication to D.M. Nemeth, Science Applications International Corporation, Germantown, MD, *Transportation Improvements in Texas*, September 10.

NOAA (National Oceanic and Atmospheric Administration), 1994a, *Local Climatological Data, Annual Summary With Comparative, Data, 1993*, "Amarillo, Texas (AMA)" National Environmental Satellite, Data, and Information Service, National Climatic Data Center, Asheville, NC, November 29.

NOAA (National Oceanic and Atmospheric Administration), 1994b, *Local Climatological Data, Annual Summary With Comparative Data, 1993*, "Augusta, Georgia" National Environmental Satellite, Data, and Information Service, National Climatic Data Center, Asheville, NC, November 29.

Noah, J.C., compiler, 1995, *Land-Use Baseline Report, Savannah River Site*, WSRC-TR-95-0276, Westinghouse Savannah River Company, Aiken, SC, June.

NPS (U.S. National Park Service), 1994, *Hanford Reach of the Columbia River Comprehensive River Conservation Study and Environmental Impact Statement*, Final, Pacific Northwest Regional Office, Seattle, WA, June.

[Text deleted.]

NRC (U.S. Nuclear Regulatory Commission), 1997, *NRC Information Digest: 1997 Edition*, NUREG-1350, vol. 9, Division of Budget and Analysis, Office of the Chief Financial Officer, Washington, DC, http://www.nrc.gov/NRC/NUREGS/SR1350/V9/sr1350.html#_1_1.

NRC (U.S. Nuclear Regulatory Commission), 1998, *NRC Issues License for Spent Fuel Storage Installation at North Anna Nuclear Power Plant*, Press Release No. 98-110, Office of Public Affairs, Washington, DC, July 2.

NRC (U.S. Nuclear Regulatory Commission), 1999, *Nuclear Plant Information Books*, Washington, DC, http://www.nrc.gov/OPA/finder.htm#pib.

NUS (NUS Corporation), 1990, *Sound-Level Characterization of the Savannah River Site*, NUS-5251, Aiken, SC, August.

O'Connor, D.G., et al., 1998a, *Hanford MOX Fuel Lead Assemblies Data Report for the Surplus Plutonium Disposition Environmental Impact Statement*, ORNL/TM-13481, Lockheed Martin Energy Research Corporation, Oak Ridge, TN.

O'Connor, D.G., et al., 1998b, *ANL–W MOX Fuel Lead Assemblies Data Report for the Surplus Plutonium Disposition Environmental Impact Statement*, ORNL/TM-13478, Lockheed Martin Energy Research Corporation, Oak Ridge, TN.

O'Connor, D.G., et al., 1998c, *LLNL MOX Fuel Lead Assemblies Data Report for the Surplus Plutonium Disposition Environmental Impact Statement*, ORNL/TM-13480, Lockheed Martin Energy Research Corporation, Oak Ridge, TN.

O'Connor, D.G., et al., 1998d, *LANL MOX Fuel Lead Assemblies Data Report for the Surplus Plutonium Disposition Environmental Impact Statement*, ORNL/TM-13482, Lockheed Martin Energy Research Corporation, Oak Ridge, TN.

O'Connor, D.G., et al., 1998e, *SRS MOX Fuel Lead Assemblies Data Report for the Surplus Plutonium Disposition Environmental Impact Statement*, ORNL/TM-13483, Lockheed Martin Energy Research Corporation, Oak Ridge, TN.

Peña, F., 1997, U.S. Department of Energy, personal communication to Secretarial Officers and Heads of Field Elements, U.S. Department of Energy, *Lessons Learned From the Emergency Management of the May 14, 1997 Explosion at Hanford's Plutonium Reclamation Facility*, August.

Randolph, L., 1997, American Medical Association, Chicago, IL, personal communication to D.M. Nemeth, Science Applications International Corporation, Germantown, MD, *Information on Physicians by State and County, 1996*, August.

| Reynolds, T.D., 1999, Environmental Science and Research Foundation, Idaho Falls, ID, personal
| communication to J.R. Schinner, Science Applications International Corporation, Germantown, MD, June 22.

Rhoderick, J., 1998, U.S. Department of Energy, Office of Environmental Management, Washington, DC, personal communication to M. Jones, U.S. Department of Energy, Office of Fissile Materials Disposition, Washington, DC, *Review of Waste Management Facilities for Surplus Plutonium Disposition (SPD) EIS*, April 30.

| Ritchey, K., 1996, *First Impressions Newcomer's Guide, Charlotte Metro*, "Lake Norman Area Services and
| Attractions," RE/MAX Lake and Land, Cornelius, NC.

Rohl, D.A., 1994, *Hanford Site Water Systems Plan, Site Utilities Program*, RL-WSP-94-01, U.S. Department of Energy, Richland Operations Office, Richland, WA, April.

Roy, R., 1998, U.S. Department of the Interior, Fish and Wildlife Service, Moses Lake, WA, personal communication to M. Jones, U.S. Department of Energy, Office of Fissile Materials Disposition, Washington, DC, *Surplus Plutonium Disposition Environmental Impact Statement FWS Reference: 1-9-99-SP-052*, December 3.

Ruesink, R., 1998, U.S. Department of the Interior, Fish and Wildlife Service, Snake River Basin Office, Boise, ID, personal communication to M. Jones, U.S. Department of Energy, Office of Fissile Materials Disposition, Washington, DC, *Surplus Plutonium Disposition–Section 7 Consultation File #506.0000, SP #1-4-98-SP-247*, August 18.

Sadler, M., 1997, South Carolina Department of Health and Environmental Control, Columbia, SC, personal communication to A. Grooms, Duke Energy, *Duke Energy/Catawba Nuclear NPDES Permit #SC0004278*, September 29.

Sandberg, D., 1998a, B&W Hanford Company, Richland, WA, personal communication to J. DiMarzio, Science Applications International Corporation, Germantown, MD, *Some Answers to Additional Questions of the Affected Environments at the Sites*, April 30.

Sandberg, D., 1998b, B&W Hanford Company, Richland, WA, personal communication to J. DiMarzio, Science Applications International Corporation, Germantown, MD, *300 Area Treated Effluent Disposal Facility*, April 2.

Sandberg, D., 1998c, B&W Hanford Company, Richland, WA, personal communication to J. DiMarzio, Science Applications International Corporation, Germantown, MD, *200 Area Fuel Usage*, February 25.

SCDHEC (South Carolina Department of Health and Environmental Control), 1995, *South Carolina Air Quality Annual Report*, vol. XV.

SCDHEC (South Carolina Department of Health and Environmental Control), 1996, *Regulation 61-62, Air Pollution Control Regulations and Standards*, Standard 2, "Ambient Air Quality Standards"; Standard 8, "Toxic Air Pollutants," Air Pollution Control, Columbia, SC.

Sessions, J., 1997a, Westinghouse Savannah River Company, Aiken, SC, personal communication to K. Gandee, U.S. Department of Energy, Office of Fissile Materials Disposition, Washington, DC, *Surplus Pu Disposition EIS Savannah River Site Affected Environment*, August 4.

Sessions, J., 1997b, Westinghouse Savannah River Company, Aiken, SC, personal communication to J. DiMarzio, Science Applications International Corporation, Germantown, MD, *Request for Waste Management Information*, October 1.

Sessions, J., 1997c, Westinghouse Savannah River Company, Aiken, SC, personal communication to K. Gandee, U.S. Department of Energy, Office of Fissile Materials Disposition, Washington, DC, *Surplus Pu Disposition EIS Savannah River Site Affected Environemental Data Call*, ESH-EAP-97-0057, June 9.

Sessions, J., 1998a, Westinghouse Savannah River Company, Aiken, SC, personal communication to J. DiMarzio, Science Applications International Corporation, Germantown, MD, *Coal & Oil*, February 2.

Sessions, J., 1998b, Westinghouse Savannah River Company, Aiken, SC, personal communication to John DiMarzio, Science Applications International Corporation, Germantown, MD, *Reply to Additional Questions on Affected Environment*, January 26.

SRARP (Savannah River Archaeological Research Program), 1989, *Archaeological Resource Management Plan of the Savannah River Archaeological Research Program*, South Carolina Institute of Archaeology and Anthropology, University of South Carolina, Columbia, SC, December.

SRARP (Savannah River Archaeological Research Program), 1997, *Preliminary Archaeological Assessment of the Proposed Plutonium Immobilization Plant, Savannah River Site, Aiken County, South Carolina*, South Carolina Institute of Archaeology and Anthropology, University of South Carolina, Columbia, SC, November 24.

Stephens, G., 1998, Idaho Department of Fish and Game, Idaho Conservation Data Center, Boise, ID, personal communication to M. Jones, U.S. Department of Energy, Office of Fissile Materials Disposition, Washington, DC, *Input Relative to Special Status Species Associated with INEEL and Construction at the Idaho Nuclear Technology and Energy Center (INTEC)*, August 12.

Stephens, G., 1999, Idaho Department of Fish and Game, Idaho Conservation Data Center, Boise, ID, personal communication (facsimile) to K. Folk, Science Applications International Corporation, Germantown, MD *INTEC Area at INEEL*, Reply to Questions Relative to the Database Search for Information on Special-Status Species, February 12.

Stephenson, K., and A. King, 1999, Savannah River Archaeological Research Program, South Carolina Institute of Archaeology and Anthropology, Aiken, SC, personal communication to D. Ryan, U.S. Department of Energy, Savannah River Operations Office, Aiken, SC, *Surplus Plutonium Disposition Facility Survey Update*, August 26.

Sullivan, M., 1997, South Carolina Highway Administration, Columbia, SC, personal communication to D.M. Nemeth, Science Applications International Corporation, Germantown, MD, *Transportation Improvements in South Carolina*, September 11.

Teal, J., 1997, Science Applications International Corporation, Richland, WA, personal communication to J. DiMarzio, Science Applications International Corporation, Germantown, MD, *Reply to "Hanford Infrastructure – Unresolved Issues*," September 24.

TNRCC (Texas Natural Resource Conservation Commission), 1997a, *TNRCC Rules*: 101, "General Rules (Air Quality)"; 112, "Control of Air Pollution from Sulfur Compounds (Reg. II)"; 113, "Control of Air Pollution from Toxic Materials (Reg. III)," Austin, TX.

TNRCC (Texas Natural Resource Conservation Commission), 1997b, Toxicology and Risk Assessment (TARA) Section Staff, memo to Interested Parties, *Effects Screening Levels (ESLs) List*, Austin, TX, September 5.

TNRCC (Texas Natural Resource Conservation Commission), 1997c, *Pantex Nuclear Weapons Facility Ambient Air Monitoring Annual 1995 Report*, AS-70, Monitoring Operations Division, Austin, TX, January.

Triay, I., 1999, U.S. Department of Energy, Los Alamos National Laboratory, Los Alamos, NM, personal communication (telephone conversation) with John DiMarzio, Science Applications International Corporation, Germantown, MD, *TRU Waste Processing Capacity*, April 7.

UC (Regents of the University of California), 1996, *Environmental Surveillance at Los Alamos During 1995*, LA-13210-ENV, October.

UC (Regents of the University of California), 1999, *Fissile Materials Disposition Program, EIS Data Call Report: Plutonium Immobilization Plant Using Glass in New Facilities at the Savannah River Site,* rev. 1, UCRL-ID-128271, Lawrence Livermore National Laboratory, Livermore, CA, September.

VADEQ (Commonwealth of Virginia, Department of Environmental Quality), 1997, *Authorization to Discharge Under the Virginia Pollutant Discharge Elimination System and the Virginia State Water Control Law,* Permit No. VA0052451, November 18.

Virginia Power (Virginia Electric & Power Company), 1998, *North Anna Power Station Updated Final Safety Analysis Report,* rev. 32, Richmond, VA, February 11.

WDEC (Washington Department of Ecology), 1994, *Washington Administrative Code, Title 173*: Chapter 173-460, "Controls for New Sources of Toxic Air Pollutants"; Chapter 173-470, "Standards for Particulate Matter"; Chapter 173-474, "Ambient Air Quality Standards for Sulfur Oxides"; Chapter 173-475, "Ambient Air Quality Standards for Carbon Monoxide, Ozone, and Nitrogen Dioxide"; Chapter 173-481, "Ambient Air Quality and Environmental Standards for Fluorides."

Weinreich, W.A., 1997, Mason & Hanger Corporation, Amarillo, TX, personal communication to J.S. Johnson, U.S. Department of Energy, Amarillo Area Office, Amarillo, TX, *Visual Examination of Storm Water Runoff per the Multi-Sector Permit; WAD Deliverable No. 10-13d,* December 30.

Werner, J., 1997, U.S. Department of Energy, Idaho Operations Office, Idaho Falls, ID, personal communication to K. Gandee, U.S. Department of Energy, Office of Fissile Materials Disposition, Washington, DC, *Data Call for the INEEL Affected Environments,* August 4.

WSRC (Westinghouse Savannah River Company), 1994, *Fact Sheet on Savannah River Site Fire Department,* www.srs.gov/general/aboutsrs/pub_rel/factsheets/fact_sheet_27.html, Administration and Infrastructure Division, Aiken, SC, May 3.

WSRC (Westinghouse Savannah River Company), 1997a, *SRS News Highlights, This Month's Top Stories, CIF: Starting a New Era of Waste Management at SRS,* from www.srs.gov/general/aboutsrs/pub_rel/srsnews.html#STORYONE, Public Relations Department, Aiken, SC, September 2.

WSRC (Westinghouse Savannah River Company), 1997b, *SRS Ecology Environmental Information Document,* WSRC-TR-97-0223, Aiken, SC.

Zahn, K.C., 1998, Lawrence Livermore National Laboratory, Livermore, CA, personal communication to C. Groome, Science Applications International Corporation, Germantown, MD, *Revisions to March 1998 Preliminary Draft Surplus Plutonium Disposition EIS,* April 3.