DOE/EIS-0236
Vol. 2 of 4

Final Programmatic Environmental Impact Statement for Stockpile Stewardship and Management

Volume II

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CONTACT: For additional information on this statement, write or call:

Mr. Jay Rose
Reconfiguration Group,
Office of Technical and Environmental Support, DP-45
United States Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585
Attention: SSM PEIS
Telephone: (202) 586-5484

For general information on the DOE *National Environmental Policy Act* process, write or call:

Ms. Carol M. Borgstrom, Director
Office of NEPA Policy and Assistance, EH-42
United States Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585
Telephone: (202) 586-4600
or leave a message at (800) 472-2756

ABSTRACT: In response to the end of the Cold War and changes in the world's political regimes, the United States is not producing new-design nuclear weapons. Instead, the emphasis of the U.S. nuclear weapons program is on reducing the size of the Nation's nuclear stockpile by dismantling existing nuclear weapons. The Department of Energy (DOE) has been directed by the President and Congress to maintain the safety and reliability of the reduced nuclear weapons stockpile in the absence of underground nuclear testing. In order to fulfill that responsibility, DOE has developed a Stockpile Stewardship and Management Program to provide a single highly integrated technical program for maintaining the continued safety and reliability of the nuclear stockpile. The Stockpile Stewardship and Management PEIS describes and analyzes alternative ways to implement the proposed actions for the Stockpile Stewardship and Management Program.

Stockpile stewardship refers to activities associated with research, design, development and testing of nuclear weapons and the assessment and certification of the safety and reliability. The stockpile stewardship portion of the PEIS evaluates the potential impacts of three proposed facilities: the National Ignition Facility (NIF), the Contained Firing Facility (CFF), and the Atlas Facility. The stockpile stewardship alternatives involving these facilities could affect four sites: Los Alamos National Laboratory (LANL), Lawrence Livermore National Laboratory (LLNL), Sandia National Laboratories (SNL), and Nevada Test Site (NTS).

Stockpile management refers to activities associated with the production, maintenance, surveillance, refurbishment, and dismantlement of the nuclear weapons stockpile. The stockpile management portion of this PEIS evaluates the potential impacts of carrying out stockpile management alternatives at eight sites: Oak Ridge Reservation (ORR), Savannah River Site (SRS), Kansas City Plant (KCP), Pantex Plant (Pantex), LANL, LLNL, SNL, and NTS. The stockpile management alternatives are assessed for nuclear weapons assembly/disassembly and for fabricating pits, secondaries and cases, high explosives, and nonnuclear components.

The Stockpile Stewardship and Management PEIS also evaluates the No Action alternative of relying on existing facilities and continuing the missions at current sites to achieve both the stockpile stewardship and management missions. The No Action alternative assesses the environmental impacts of the on-going Stockpile Stewardship and Management Program and provides a baseline against which alternatives can be evaluated.

DOE has identified the following preferred alternative for the Stockpile Stewardship and Management Program:

Stockpile Stewardship:
- Construct and operate NIF at LLNL
- Construct and operate CFF at LLNL
- Construct and operate the Atlas Facility at LANL

Stockpile Management:
- Secondary and Case Component Fabrication—downsize the Y-12 Plant at ORR
- Pit Component Fabrication—reestablish capability and appropriate capacity at LANL

- Assembly/Disassembly—downsize at Pantex
- High Explosives Fabrication—downsize at Pantex
- Nonnuclear Component Fabrication—downsize at KCP
- Based on the analyses performed to support this PEIS, the preferred alternatives for strategic reserve storage are as follows: (1) highly enriched uranium strategic reserve storage at Y–12; and (2) plutonium pit strategic reserve storage in Zone 12 at Pantex. The preferred alternatives for strategic reserve storage could change based upon decisions to be made in regard to the *Storage and Disposition of Weapons-Usable Fissile Materials Final PEIS*. Decisions on strategic storage will not be made in the upcoming ROD for the Stockpile Stewardship and Management Program. Storage decisions are not expected to be made until both the *Stockpile Stewardship and Management Final PEIS* and the *Storage and Disposition of Weapons-Usable Fissile Materials Final PEIS* are completed.

The preferred alternative for plutonium-242 oxide at SRS is to transport the material to LANL for storage.

Evaluation of impacts on land resources, site infrastructure, air quality, water resources, geology and soils, biotic resources, cultural and paleontological resources, socioeconomics, waste management, environmental justice, as well as radiological and hazardous chemical impacts during normal operation and accidents to workers and the public are included in the assessment. The PEIS presents unclassified information only. A classified appendix has also been prepared to support the PEIS.

PUBLIC COMMENTS: The public comment period on the Draft PEIS was conducted from March 8, 1996 to May 7, 1996. During the comment period, public hearings were held in Los Alamos, NM; Albuquerque, NM; Las Vegas, NV; Oak Ridge, TN; Kansas City, MO; Livermore, CA; Washington, DC; Amarillo, TX; Santa Fe, NM; and North Augusta, SC. The Draft PEIS was made available through mailings, requests to DOE's Office of Reconfiguration, and at DOE Public Reading Rooms. In preparing the Final PEIS, DOE considered comments received by mail, fax, handed in at hearings, transcribed from messages recorded by telephone, and those transcribed via Internet. In addition, comments and concerns identified during discussions at public hearings were considered.

In response to comments submitted after issuance of the Draft PEIS and due to additional technical details not available at the time of issuance of the Draft, Volumes I, II, and III of the Final PEIS contain revisions and changes. The revisions and changes made since the issuance of the Draft document are indicated by a double underline for minor word changes or by a sidebar in the margin for paragraph or larger changes. In addition, Volume I and each appendix in Volume III provide a unique reference list to enable the reader to further review and research selected topics. Volume IV (Comment Response Document) of the PEIS contains the comments received during public review of the Draft PEIS and the DOE responses to those comments. DOE has public reading rooms near each affected site and in Washington, DC where these referenced documents may be reviewed or obtained for review.

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ACRONYMS, ABBREVIATIONS, AND CONVERSION CHARTS

1

Acronyms, Abbreviations, and Conversion Charts

ACRONYMS AND ABBREVIATIONS

A/D	assembly/disassembly
AEC	Atomic Energy Commission
AHF	Advanced Hydrotest Facility
AQCR	Air Quality Control Region
ARS	Advanced Radiation Source
BEBA	beyond evaluation basis accident
BEEF	Big Explosives Experimental Facility
BEIR	biological effects of ionizing radiation
CAA	*Clean Air Act*
CEQ	Council on Environmental Quality
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act*
CFF	Contained Firing Facility
CFR	Code of Federal Regulations
Complex	Nuclear Weapons Complex
CTBT	Comprehensive Test Ban Treaty
CWA	*Clean Water Act*
DARHT	Dual Axis Radiographic Hydrodynamic Test (Facility)
D&D	decontamination and decommissioning
DOD	Department of Defense
DOE	Department of Energy
DOT	Department of Transportation
DP	DOE Office of the Assistant Secretary for Defense Programs
EA	environmental assessment
EBA	evaluation basis accident
EIS	environmental impact statement
EM	DOE Office of the Assistant Secretary for Environmental Management
EPA	Environmental Protection Agency
ES&H	environment, safety, and health
FONSI	Finding of No Significant Impact
FXR	Flash X-Ray (Facility)
HAP	hazardous air pollutants
HE	high explosives
HEPA	high efficiency particulate air (filter)
HEPPF	High Explosive Pulsed Power Facility
HEU	highly enriched uranium
HI	hazard index
HLW	high-level waste
HQ	hazard quotient
ICRP	International Commission on Radiological Protection
INEL	Idaho National Engineering Laboratory
IP	implementation plan
ICST	Industrial Complex Short-Term (model)
K-25	K-25 Site, Oak Ridge Reservation
KCP	Kansas City Plant
LANL	Los Alamos National Laboratory
LLNL	Lawrence Livermore National Laboratory
LLW	low-level waste

NAAQS	National Ambient Air Quality Standards
NEPA	*National Environmental Policy Act*
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NIF	National Ignition Facility
NLVF	North Las Vegas Facility
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NPR	Nuclear Posture Review
NPT	Non-Proliferation Treaty
NRC	Nuclear Regulatory Commission
NRHP	National Register of Historic Places
NTS	Nevada Test Site
NWSM	Nuclear Weapon Stockpile Memorandum
NWSP	Nuclear Weapon Stockpile Plan
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
OSHA	Occupational Safety and Health Administration
Pantex	Pantex Plant
PBFA II	Particle Beam Fusion Accelerator
PDD	Presidential Decision Directive
PEIS	programmatic environmental impact statement
PHERMEX	Pulsed High Energy Radiation Machine Emitting X-Rays (Facility)
PL	Public Law
R&D	research and development
RCRA	*Resource Conservation and Recovery Act*
RD&T	research, development, and testing
RIMS	Regional Input-Output Modeling System
ROD	Record of Decision
ROI	region of influence
SAR	Safety Analysis Report
SARA	*Superfund Amendments and Reauthorization Act*
SDWA	*Safe Drinking Water Act*
SMR	standardized mortality ratio
SHPO	State Historic Preservation Officer
SNL	Sandia National Laboratories/New Mexico
SRS	Savannah River Site
START	Strategic Arms Reduction Talks
TA	technical area
TLV-TWA	threshold limit value-time weighted average
TRU	transuranic
TSCA	*Toxic Substances Control Act*
TSP	total suspended particulates
USFWS	U.S. Fish and Wildlife Service
VOCs	volatile organic compounds
Y-12	Y-12 Plant, Oak Ridge Reservation
WIPP	Waste Isolation Pilot Plant

CHEMICALS AND UNITS OF MEASURE

Bq	Becquerel
C	Celsius
Ci	curie
CCl_4	carbon tetrachloride
cm	centimeters
CFC	chlorofluorocarbons
CO	carbon monoxide
dB	decibel
dBA	decibel A-weighted
DCE	1, 2-dichloroethylene
F	Fahrenheit
ft	feet
ft^2	square feet
ft^3	cubic feet
ft^3/s	cubic feet per second
g	grams
gal	gallons
GPD	gallons per day
gpm	gallons per minute
GPY	gallons per year
ha	hectares
hr	hour
in	inches
kg	kilograms
km	kilometers
kV	kilovolts
kVA	kilovolt-ampere
kW	kilowatts
kWh	kilowatt hours
L	liters
lb	pounds
Li	lithium
m	meters
m^2	square meters
m^3	cubic meters
m^3/s	cubic meters per second
mCi	millicurie (one-thousandth of a curie)
mCi/ml	millicurie per milliliter
mg	milligram (one-thousandth of a gram)
mg/L	milligrams per liter
MGY	million gallons per year
mi	miles
MLY	million liters per year
mph	miles per hour
mrem	millirem (one-thousandth of a rem)

MVA	megavolt-ampere
MW	megawatt
MWe	megawatt electric
MWh	megawatt hour
MWt	megawatt thermal
nCi	nanocurie (one-billionth of a curie)
nCi/g	nanocuries per gram
NO_2	nitrogen dioxide
NO_X	nitrogen oxides
O_3	ozone
Pb	lead
PCB	polychlorinated biphenyl
pCi	picocurie (one-trillionth of a curie)
pCi/l	picocuries per liter
PM_{10}	particulate matter (less than 10 microns in diameter)
ppb	parts per billion
ppm	parts per million
rem	roentgen equivalent man
SO_2	sulfur dioxide
t	metric tons
TATB	triaminotrinitrobenzene
TCA	1, 1, 1-trichloroethane
TCE	trichloroethylene
TNT	trinitrotoluene
yd^3	cubic yards
yr	year
µCi	microcurie (one-millionth of a curie)
µCi/g	microcuries per gram
µg	microgram (one-millionth of a gram)
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
$\mu g/m^3$	micrograms per cubic meter
µ	micron or micrometer (one-millionth of a meter)

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					
square inches	6.4516	square centimeters	square centimeters	0.155	square inches
square feet	0.092903	square meters	square meters	10.7639	square feet
square yards	0.8361	square meters	square meters	1.196	square yards
acres	0.40469	hectares	hectares	2.471	acres
square miles	2.58999	square kilometers	square kilometers	0.3861	square 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
Force					
dynes	0.00001	newtons	newtons	100,000	dynes
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}

APPENDIX A

APPENDIX A: STOCKPILE STEWARDSHIP AND MANAGEMENT FACILITIES

The Nuclear Weapons Complex (Complex) comprises facilities located at eight major U.S. Department of Energy (DOE) sites, distributed over seven states. Summary descriptions of the Complex sites are presented in chapter 3. This appendix provides more detailed information.

The eight DOE sites described in appendix A include the Oak Ridge Reservation (ORR), the Savannah River Site (SRS), the Kansas City Plant (KCP), the Pantex Plant (Pantex), Los Alamos National Laboratory (LANL), Lawrence Livermore National Laboratory (LLNL), Sandia National Laboratories (SNL), and the Nevada Test Site (NTS). The first section of this appendix provides reference operating assumptions for each of these sites. Information provided includes specific site descriptions, current missions, and environmental regulatory compliance activities associated with ongoing DOE Office of the Assistant Secretary for Defense Programs (DP), and other DOE and non-DOE programs.

Detailed descriptions of the proposed stockpile stewardship projects can be found in the project-specific analyses contained in appendixes I, J, and K for the National Ignition Facility (NIF), Contained Firing Facility (CFF), and Atlas Facility, respectively.

The last section of this appendix provides detailed descriptions of the stockpile management alternatives. Each description includes specific information describing missions, assumptions, functional parameters, expected capabilities, process descriptions, special process requirements, utilities, chemicals used, operational resources, and transportation.

A.1 Reference Operating Assumptions

The reference base for this Programmatic Environmental Impact Statement (PEIS) is No Action, which is defined in chapter 3. Section 3.3 defines No Action for stewardship and section 3.4 defines No Action for management. No Action allows a comparison of stockpile stewardship and management alternatives for the candidate sites against the configuration as it would be expected to operate in 2005 and beyond, not against the current nuclear weapons facility configuration.

No Action assumes that all sites of the Complex would continue their current nuclear weapons-related missions with existing facilities that can comply with environment, safety, and health (ES&H) requirements, and at a production or research level that is consistent with current DOE guidance. The basic nuclear weapons missions assigned to the sites include researching, developing, and testing; maintaining nuclear weapons production and testing capability; processing and storing nuclear materials; operating an extensive transportation safeguards system to assure the safe, secure movement of weapons and strategic quantities of nuclear materials within the continental United States; and cooperating with the Department of Defense (DOD) in responding to nuclear accidents or incidents throughout the world.

Under No Action, the siting and construction of major new stockpile stewardship and management facilities would not occur, there would be no upgrades or modifications to existing facilities other than routine maintenance and repairs, no nuclear weapons missions would be transferred, and future support of the nuclear weapons stockpile would be provided within the confines of the existing Complex capabilities. Some mission requirements for maintenance of the weapons stockpile in the future would not be met under No Action; however, No Action includes those mission requirements as a comparison for the stockpile stewardship and management alternatives. The No Action alternative assumes that weapons Complex sites would continue existing waste management programs which currently support weapons work to meet legal requirements and commitments in formal agreements and would proceed with ongoing cleanup activities related to past weapons work at these sites. Production facilities and support roles at specific sites, however, would be downsized or eliminated in accordance with the reduced workload projected for 2005 and beyond. Facilities that could not comply with requirements would no longer be used.

Detailed reference descriptions of the affected sites follow. These descriptions include discussions of the site location, missions, facility operations, and environmental regulatory compliance. Seismic

one locations of alternative sites are shown in igure A.1–1.

A.1.1 Oak Ridge Reservation

Site Description. ORR consists of approximately 13,980 hectares (ha) (34,545 acres) of Federal-owned lands located directly to the west and south, but within the incorporated city limits of Oak Ridge, TN. The residential section of Oak Ridge forms the northern boundary of the reservation. The Tennessee Valley Authority's Melton Hill and Watts Bar reservoirs on the Clinch and Tennessee Rivers form the eastern, southern, and western boundaries. The city of Oak Ridge and ORR are within the region known as the Great Valley of the Tennessee River, which lies between the Cumberland and Great Smoky Mountains. About 16 kilometers (km) (10 miles [mi]) to the northwest, the Cumberland Mountains rise to an elevation of 914 meters (m) (3,000 feet [ft]) or more, while the Great Smoky Mountains National Park reaches to heights over 2,000 m (6,600 ft) some 113 km (70 mi) to the southeast. The largest city in the area, Knoxville, is located approximately 48 km (30 mi) to the southeast. Land use in the five-county area surrounding ORR varies from the heavily populated and highly developed urban areas around Knoxville to the sparsely populated areas immediately surrounding ORR. The largest single land use for each of the five counties is forestry; the second most common land use is agriculture. The locations of ORR and its principal facilities are shown in figures A.1.1–1 and A.1.1–2.

ORR is a Government-owned, contractor-operated reservation. The prime contractor manages the Y-12 Plant (Y-12), the K-25 site (formerly the Oak Ridge Gaseous Diffusion Plant), the Oak Ridge National Laboratory (ORNL), and most other properties on the reservation. Originally built in the early 1940s for large-scale production of fissionable material for the world's first nuclear weapon, ORR continues to be used today as a research, development, and manufacturing institution.

Y-12 Plant. Y-12 is situated on 328 ha (811 acres), 225 ha (630 acres) of which are enclosed by perimeter security fencing, at the eastern end of ORR in the location known as Bear Creek Valley. The majority of DP activities at ORR are conducted at Y-12. Primary missions include dismantling nuclear weapons components returned from the national arsenal, maintaining nuclear production capability, and providing stockpile support and storage for special nuclear materials. Y-12 also supports other Federal agencies through a Work for Others program. In addition, a technology transfer program has been established to support the U.S. industrial base by applying Y-12 expertise to a wide range of manufacturing problems. All of the current nuclear weapons have components produced at Y-12. The plant itself consists of 494 buildings containing more than 650,000 square meters (m^2) (7,000,000 square feet [ft^2]) of floor space.

Y-12 also provides processing of radioactive source materials and support for other Government agencies. Some 47 buildings containing approximately 140,000 m^2 (1,500,000 ft^2) of floorspace located on Y-12 grounds are utilized by ORNL in support of non-DP missions. ORNL employs some 450 people at Y-12. Also located on the Y-12 site are approximately 20 buildings containing 28,000 m (300,000 ft^2) that house the DOE construction manager, the water plant maintenance contractor for ORR, and several organizations of the Oak Ridge Operations Office. These activities employ 17 people in DOE and 550 people in construction manager organizations.

K-25 Site. K-25 consists of approximately 688 h (1,700 acres) and is located about 9.6 km (6 m northwest of Y-12. The site consists of 250 building with approximately 1,130,000 m^2 (12,200,000 ft^2) floor space. The primary mission of K-25 has bee providing enriched uranium for U.S. nuclear weapons and, later, providing uranium toll enrichment services for use in power reactor facilities around the world. Because of a lack of weapons commercial requirements, the gaseous diffusion process at K-25 was permanently shut down in 198 Today, K-25 serves as the operations center for environmental restoration and waste manageme programs. K-25 is also the home of DOE's Center f Environmental Technology and Center for Was Management. Missions and activities include tec nology development, technology transfer, engineering technology, uranium enrichment support, and central functions of business management, engineering, computing, and telecommunications.

Oak Ridge National Laboratory. ORNL is a la multipurpose research institution that consists approximately 1,174 ha (2,900 acres) located 6.5 l

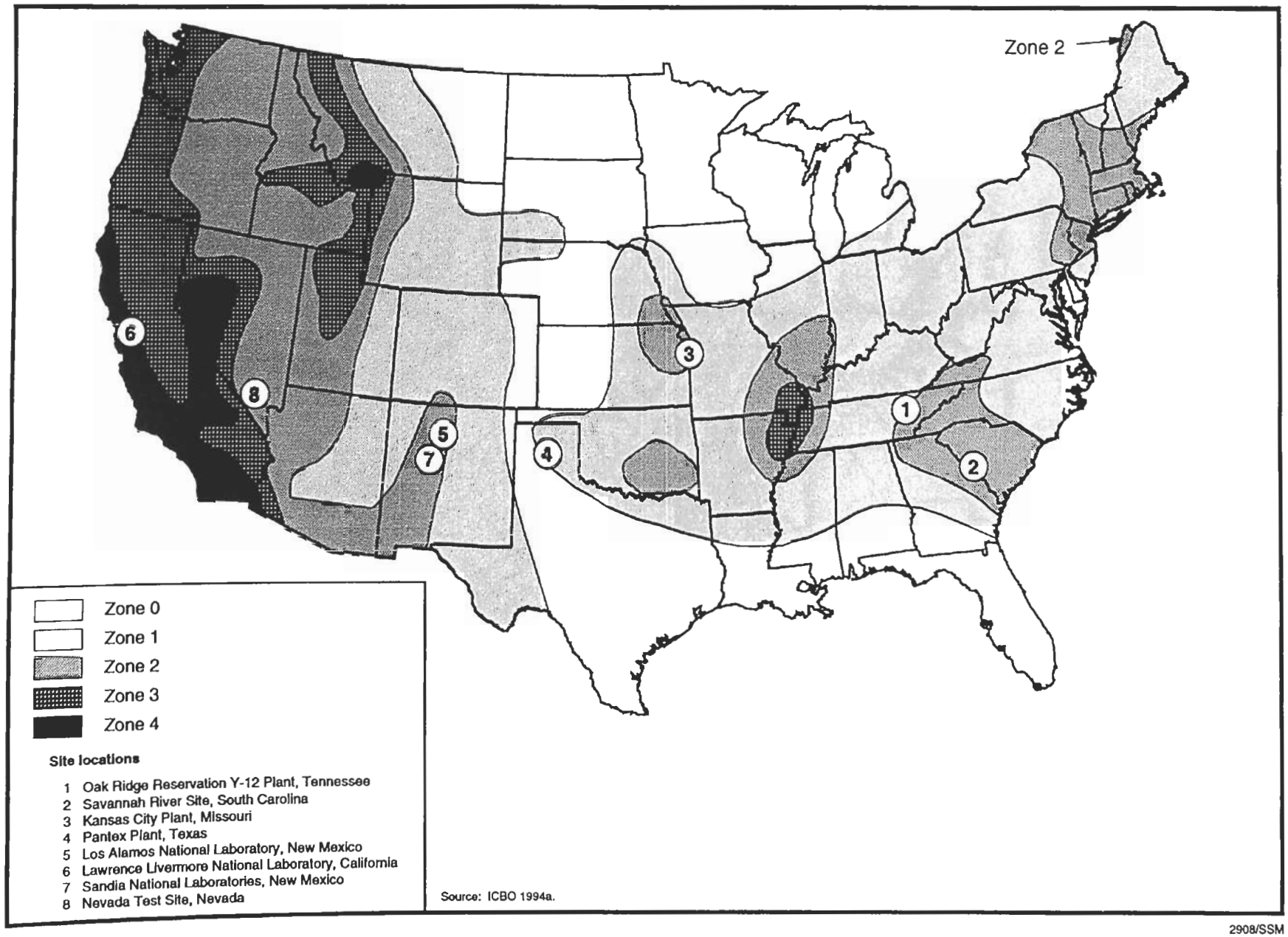

FIGURE A.1–1—*Seismic Zone Locations of Alternative Sites.*

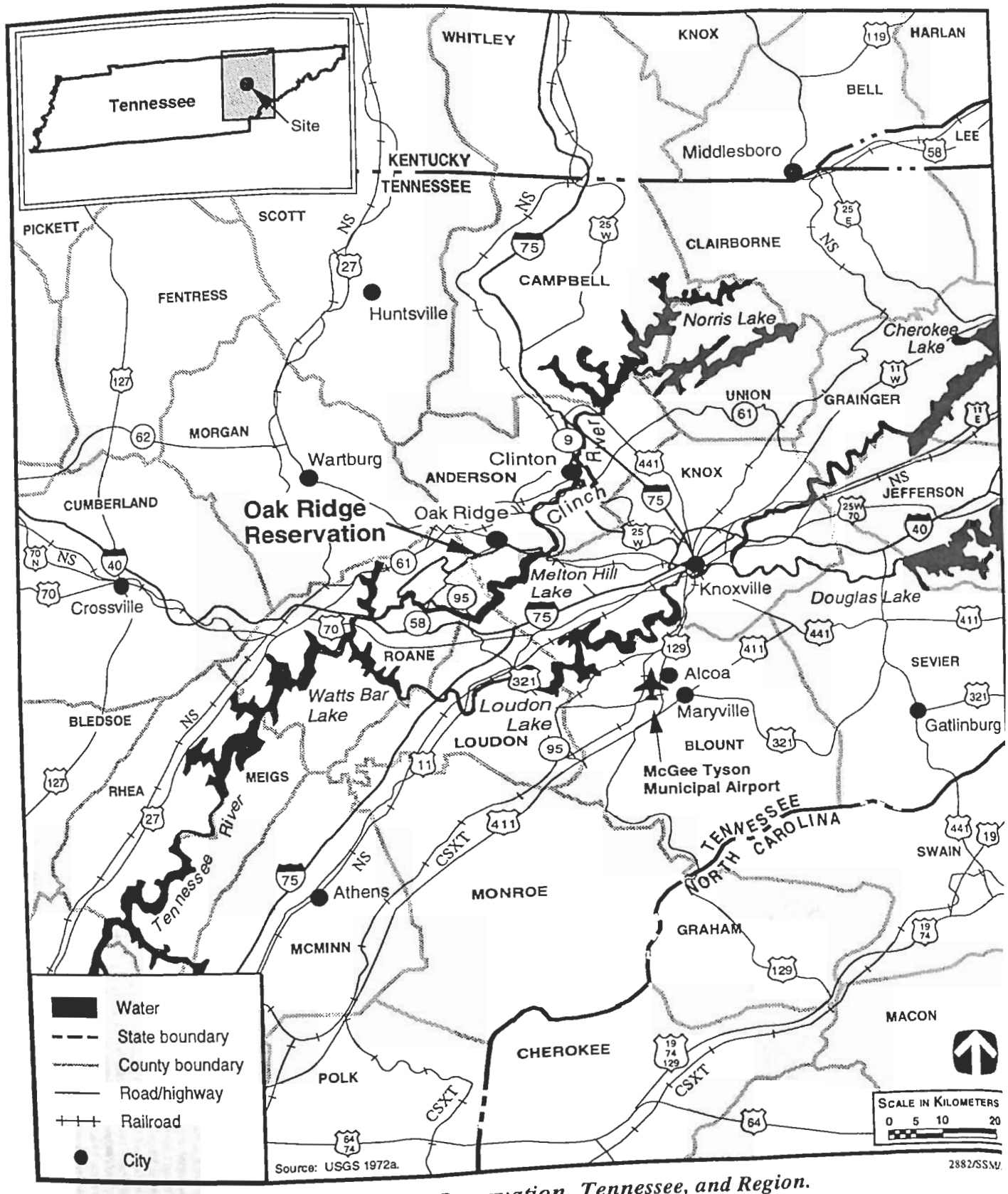

FIGURE A.1.1–1.—*Oak Ridge Reservation, Tennessee, and Region.*

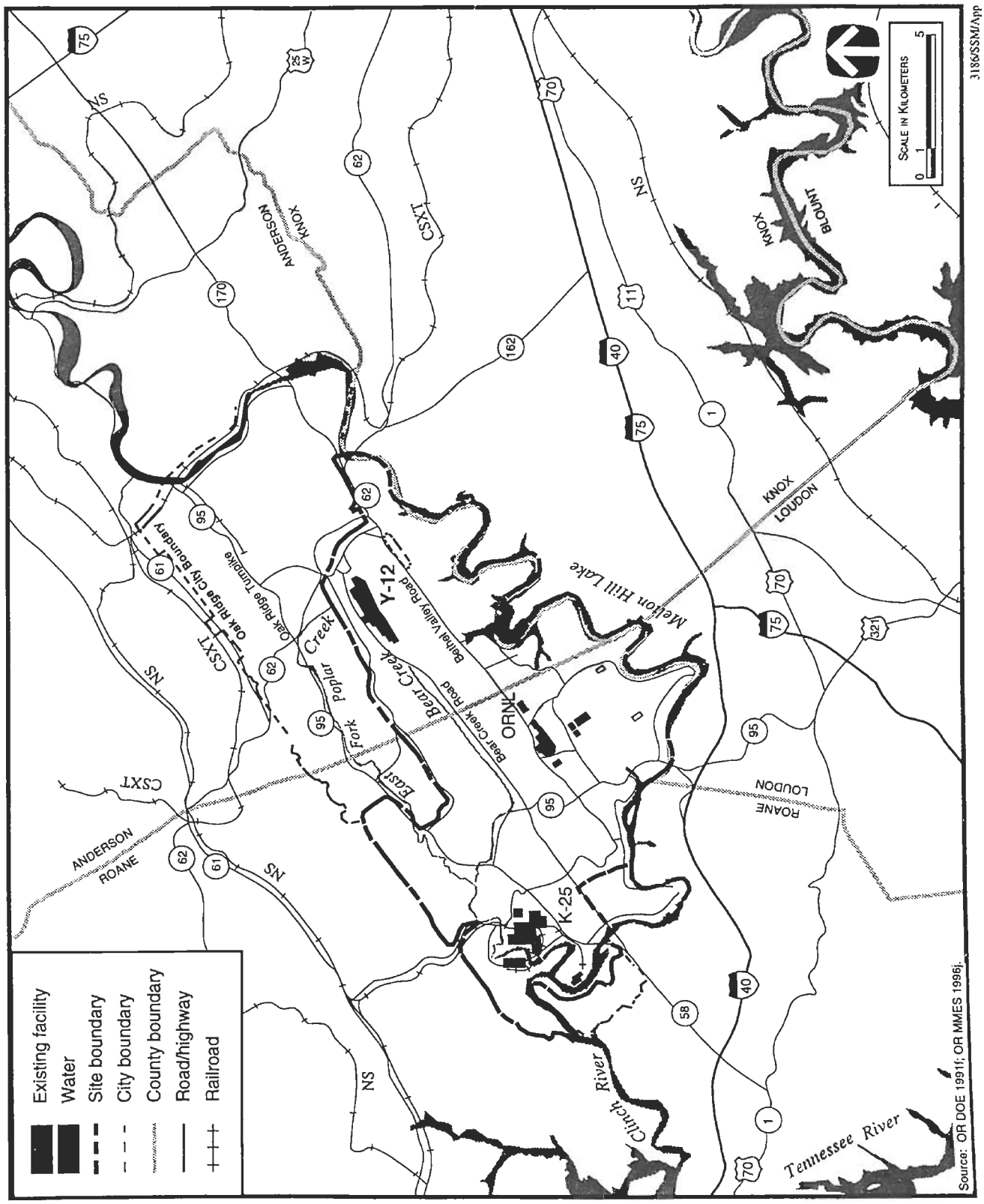

FIGURE A.1.1-2.—*Principal Facilities at Oak Ridge Reservation.*

(4 mi) southwest of Y-12. The site has approximately 240 buildings containing 250,000 m^2 (2,700,000 ft^2) of floor space. Missions and activities include energy production and conservation technologies, physical and life sciences, scientific and technological user facilities, environmental protection and waste management, science and technology transfer, and education.

ORNL programs focus on basic and applied research, technology development, and technology that has been designated important to DOE and the Nation. It also performs work for non-DOE sponsors when such activities complement DOE missions and address significant national or international issues. ORNL facilities include a high-flux nuclear research reactor, chemical pilot plants, research laboratories, radioisotope production laboratories, accelerators, fusion test devices, and support facilities.

The onsite buildings and structures outside the major plant sites consist of the Scarboro Facility, the Central Training Facility, the Transportation Safeguards Division Maintenance Facility, and some ancillary structures. Most physical facilities used by the various plant protection and security groups are within the plant's fenced area; however, the target ranges are outside the fence but within the buffer zones of the main plant areas. Small-arms ranges are located on the eastern end of Y-12 and north of the western end of ORNL.

The offsite buildings and structures consist of the Oak Ridge Operations Office, the DOE Office of Scientific and Technical Information, the Oak Ridge Institute for Science and Education facilities, the American Museum of Science and Energy, the prime contractor's "Townsite" facilities, the National Oceanic and Atmospheric Administration's Atmospheric Turbulence and Diffusion Laboratory, and other buildings. With the exception of the Federal Office Building and space leased from the private sector, all buildings and structures used for DOE functions are situated on DOE-owned land.

The Oak Ridge National Environmental Research Park, established in 1980, consists of 5,500 ha (13,590 acres) on ORR. As one of seven DOE research parks, its purpose is to provide protected land areas for research and education in the environmental sciences and to demonstrate that energy technology development is compatible with a quality environment. There are 53 active environmental sciences research sites consisting of 1,442 ha (3,562 acres) on ORR. In addition, there are 15 inactive sites on 131 ha (323 acres).

The primary missions of the Oak Ridge Institute for Science and Education are to provide educational and research programs in the areas of health, environment, and energy for DOE, other Federal agencies, and private industry. The American Museum of Science and Energy is located at a site contiguous to the campus of Oak Ridge Institute for Science and Education. The museum contains historical displays and exhibits about energy in its various forms, as well as topical matter on the growth of the nuclear power industry.

The National Oceanic and Atmospheric Administration conducts meteorological and atmospheric diffusion research, that is supported by both itself and DOE, at the Atmospheric Turbulence and Diffusion Laboratory and field sites on ORR. This laboratory also provides services to DOE contractors and operates the weather instrument telemetering monitoring system for DOE.

Environmental Regulatory Setting. The policy of ORR is to conduct operations safely and to minimize any adverse impact of operations on the environment, ensuring incorporation of all local and national environmental-protection goals in the daily conduct of business. ORR consists of Y-12, ORNL, and K-25 and most permits and data on releases are reported by individual sites, with Y-12 being the most important site for making decisions in this PEIS. However, some environmental compliance agreements consider ORR to be a single Federal facility.

The Environmental Protection Agency (EPA) has delegated regulatory authority to the State of Tennessee for air, water, solid waste, hazardous waste, and mixed waste. The State of Tennessee and DOE have entered into a 5-year Oversight Agreement that was signed on May 13, 1991. That agreement has been extended for an additional 5 years until June 28, 2001. The purpose of this agreement is to assure Tennessee citizens that their health, safety, and the environment are being protected during ORR operations. The agreement reflects the obligations and agreements between DOE and the state regarding technical and financial support provided by DOE and the state for oversight of these activities. The agreement has provisions for modifications, as appro

priate, to address community issues that may arise. The Tennessee Department of Environment and Conservation is the lead state agency for implementation of the agreement. This agency has established a DOE Oversight Division located in the city of Oak Ridge and is staffed with over 50 employees. The Oversight Division routinely visits the three ORR sites to attend formal meetings and briefings, to conduct walk throughs of buildings and grounds, or to conduct observations of site operations to ensure compliance with environmental regulations and DOE orders.

The remainder of this section summarizes the status of Y-12 compliance with the major environmental regulations.

National Environmental Policy Act. DOE finalized the environmental assessment (EA) for the *Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Storage Level at the Y-12 Plant, Oak Ridge, Tennessee,* in September 1994, and issued a Finding of No Significant Impact (FONSI). This EA analyzed the storage of a larger quantity of enriched uranium than historically had been stored at Y-12. In its FONSI, DOE decided to store no more than 500 metric tons (t) (550 short tons [tons]) of highly enriched uranium (HEU) and 7,105.9 t (7,833 tons) of low-enriched uranium at Y-12 on an interim basis until long-term storage and disposition decisions can be made and implemented.

Comprehensive Environmental Response, Compensation, and Liability Act. ORR was placed on the National Priorities List (NPL) on December 21, 1989, making the site subject to the provisions of the *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA). As a result, DOE, EPA, and the state developed a Federal Facility Agreement for environmental restoration activities at ORR effective January 1, 1992, to serve as the interagency agreement in accordance with Section 120 of CERCLA. The agreement is intended to integrate the corrective action processes of the *Resource Conservation and Recovery Act* (RCRA) and CERCLA. EPA, DOE, and the state have negotiated the agreement to ensure that the environmental impacts associated with past and present activities at ORR are thoroughly investigated and that appropriate remedial actions or corrective measures are taken.

The Federal Facility Agreement establishes a procedural framework and schedule for developing, implementing, and monitoring response actions at ORR in accordance with CERCLA, RCRA, the *National Environmental Policy Act* (NEPA), and applicable state laws. Response actions under the agreement will achieve comprehensive remediation of releases or threatened releases of hazardous substances, hazardous wastes, pollutants, or contaminants at or from ORR. The agreement coordinates responses and remedial activities necessary to protect human health and the environment and reduces duplication of corrective actions or administrative requirements under CERCLA and RCRA. The three parties to the agreement intend to consolidate the DOE CERCLA response obligations with the corrective action measures required under RCRA permits. The agreement also addresses technical standards for new and existing liquid low-level radioactive waste storage tanks.

Emergency Planning and Community Right-To-Know Act. Sections 311 and 312 of the act require reporting to local officials the inventories of hazardous chemicals and extremely hazardous substances. Y-12 reported inventories in 1993, which included 42 hazardous chemicals and 5 extremely hazardous substances.

Resource Conservation and Recovery Act. The three ORR sites each generate both RCRA hazardous waste and mixed waste. Y-12 conducts storage, treatment, and disposal of hazardous waste under RCRA Part B Permits, and interim-status provisions. The Hazardous and Solid Waste Amendments permit requirements for corrective actions, effective since October 25, 1986, have now been integrated into the Federal Facility Agreement previously mentioned under CERCLA.

Effective June 12, 1992, DOE and EPA completed a Federal Facilities Compliance Agreement to resolve the compliance issue of storing land-banned waste for extended periods. The agreement acknowledges that ORR is currently storing, and will continue to store, mixed waste subject to land disposal restrictions. It contains a compliance schedule that dictates the steps required to bring ORR facilities into compliance with respect to the management of mixed wastes and includes the strategies and plans for treatment of the backlog of land-banned waste.

In May 1991, a moratorium on offsite shipment of hazardous waste to non-DOE sites was placed on

DE facilities, including those on ORR. The moratorium was established to prevent waste containing ly radioactive material from being shipped to a cility that is not licensed to handle it. The moratoam essentially requires all RCRA hazardous waste enerated at ORR to be managed as mixed waste ntil appropriate procedures are developed and pproved to ensure that waste streams are free of adioactivity above background levels. Such procedures have been prepared by each of the ORR sites. -12 received approval from DOE for four procedures certifying "No Rad Added" to allow offsite hipment of hazardous wastes.

Water quality data from the exit-pathway wells at the ast end of Y-12 may indicate that the volatile organic ompounds (VOCs) carbon tetrachloride and tetrahloroethane are being transported off ORR through he Maynardville Limestone at depths of 30 to 91 m 100 to 300 ft). The monitoring well is located in a general industrial area, and no drinking water wells have been identified in the area. Property owners in he area have been notified and provided with a status eport.

The Federal Facility Compliance Act of 1992. This act is an amendment to RCRA. DOE published the Interim Mixed Waste Inventory Report in April 1993, annual updates, and periodic updates describing its inventory of mixed wastes and treatment capabilities. ORR prepared and submitted to the state in October 1993 a conceptual site treatment plan for ORR. In accordance with the *Federal Facility Compliance Act*, a Commissioner's Order issued on September 26, 1995, by the State of Tennessee, to become effective on October 2, 1995, included the Site-Specific Treatment Plan for Mixed Waste at ORR. This order allows ORR to store existing quantities of mixed waste and requires DOE to comply with a site treatment plan. The site treatment plan contains milestones and target dates for DOE to characterize and treat its inventory of mixed waste.

Clean Water Act. National Pollutant and Discharge Elimination System (NPDES) permits are required for each ORR facility. The Y-12 NPDES permit was issued April 28, 1995, and encompasses about 150 active point-source discharges requiring compliance monitoring. The new NPDES permit covers stormwater discharges, as well as point source discharges. The number of permitted-outfalls continues to decline as the outfalls are consolidated or eliminated, or as changes in implementation occur at the site. Through monitoring of discharges, DOE can demonstrate that Y-12 has achieved an NPDES permit compliance rate in 1993 of more than 99 percent.

Sanitary wastewater from Y-12 is discharged to the city of Oak Ridge under an industrial pretreatment permit. The Y-12 sanitary sewer upgrade project is an example of DOE corrective actions to achieve and maintain the Y-12 sanitary sewer collection system in regulatory compliance with the city of Oak Ridge sanitary sewer use ordinance and pretreatment permit. As part of the upgrade, a new monitoring station was completed in July 1994 and allows for more accurate monitoring of the sanitary sewage discharges by Y-12.

Activities are underway to reduce discharges of pollutants to surface waters of ORR. For example, two dechlorination systems were installed in late 1992 at key Y-12 outfalls on East Fork Poplar Creek to help control discharges of chlorine from noncontact cooling water systems and to help to eliminate chronic fish kills in the upper reaches of the creek. Additional efforts relating to reducing nonpoint-source pollutants to surface streams and cleaning up mercury pollution in the East Fork Poplar Creek are being implemented.

On January 17, 1992, Friends of the Earth, a nonprofit corporation, filed a lawsuit against DOE in Federal District Court in Knoxville, TN. The lawsuit alleged that DOE violated the NPDES permits because discharges of certain quantities of various pollutants into tributaries of the Clinch River exceeded the allowable discharge limits of the NPDES permits. Friends of the Earth filed a motion for summary judgment in October 1992, and DOE filed a cross-motion for denial of summary judgment in January 1993. Both motions are pending before the court. A second lawsuit was filed in Federal District Court by the Friends of the Earth in October 1995, alleging NPDES monitoring and reporting violations. This lawsuit is also pending.

Safe Drinking Water Act. The systems that supply drinking water to ORR are DOE-owned; therefore ORR must comply with all Federal, state, and loca requirements regarding the provision of safe drinking water. Section 1447 of the act mandates such compliance for each Federal agency having jurisdictio over a Federal-owned or Federal-maintained publi

water system. Y-12 receives water from a DOE-owned water treatment facility located northeast of Y-12. The Y-12 system is designated as a "nontransient, noncommunity" water distribution system and is subject to the Tennessee Regulations for Public Water Systems and Drinking Water Quality. These regulations allow distribution systems that do not perform water treatment to use the records sent to the state by the water-treatment facility from which water is received to demonstrate compliance with requirements.

Clean Air Act. Authority for enforcement of the act is shared between the state, for nonradioactive emission sources, and EPA, for radioactive emission sources. *Clean Air Act* (CAA) compliance is an integral part of the state air permit program which has issued air permits for construction and operating sources to all three ORR sites. Each site complies with Federal clean air regulations in addition to the State of Tennessee air-permit conditions. Major sources are appropriately permitted, and documentation of compliance is developed. All major emission sources are permitted by the state and are operating in compliance with those permits as of December 31, 1993. Y-12 has 94 active air permits covering 400 air emission points, and currently has about 290 documented exempt minor sources and about 350 exempt minor emission points.

ORR is also in full compliance with the requirements as set forth in 40 *Code of Federal Regulations* (CFR) 61, Subpart H (National Emission Standards for Emissions of Radionuclides Other than Radon from DOE Facilities), for sampling significant radionuclide emission points. Continuous emissions monitoring is performed at the K-25 incinerator and at 74 potential radiological exhaust stacks serving uranium-processing areas at Y-12. The stacks are equipped with continuous stack samplers, because these stacks are judged to have the potential to emit uranium emissions that could contribute greater than 0.1 mrem per year effective dose equivalent to an offsite individual. EPA certified that ORR had completed all of the actions required by the *May 1992 Federal Facility Compliance Agreement for Clean Air Act* (ORR Rad-NESHAP) and was considered to be in compliance with the National Emissions Standards for Hazardous Air Pollutants (NESHAP) regulations. A subsequent inspection in September 1993 confirmed such compliance.

Y-12 is also subject to an NESHAP rule for machining beryllium and currently monitors four stacks that serve beryllium machining and handling areas to demonstrate compliance with the 10 grams per day emission limit. The total beryllium emitted from Y-12 in 1993 was less than 1 gram.

Toxic Substances Control Act. The *Toxic Substances Control Act* (TSCA) requires polychlorinated biphenyl (PCB) wastes to be disposed of within 1 year from the date the PCBs are removed from service. Because of a lack of available disposal avenues, radioactive wastes contaminated with PCBs are stored at ORR sites for periods exceeding 1 year. Unauthorized uses and storage of PCBs are covered under the equipment-specific agreements with EPA or the Uranium-Enrichment PCB Federal Facilities Compliance Agreement, signed February 20, 1992. This agreement between DOE and EPA provides a vehicle for resolution of PCB issues only at K-25. The K-25 incinerator is the only facility in the Nation permitted to incinerate RCRA, PCB, and radioactive waste. This agreement allows K-25 to store such wastes generated by K-25 for periods exceeding one year.

Radioactive wastes contaminated with PCBs older than 1 year are generated by other ORR facilities, particularly Y-12, and also are stored at K-25. Several compliance issues exist at Y-12, because the Federal Facilities Compliance Agreement does not include PCB storage at Y-12. Therefore, discussions are continuing with EPA towards a new agreement that would include Y-12 and ORNL, as well as K-25. The new agreement is tentatively entitled the Oak Ridge Reservation PCB Federal Facilities Compliance Agreement. Storage concerns addressed under the existing agreement for K-25 would be included in the proposed Federal Facilities Compliance Agreement for the entire ORR. The earliest anticipated date for issuance of the PCB Federal Facility Compliance Agreement is in 1996.

Federal Insecticide, Fungicide, and Rodenticide Act. The three ORR sites maintain procedures for the storage and application of pesticides. Individuals responsible for the application of materials regulated by the *Federal Insecticide, Fungicide, and Rodenticide Act* are certified through the University of Tennessee Department of Agriculture. Safrotin®, used for the control of roaches, is the only restricted-use pesticide used at Y-12. No violations were iden-

tified during the 1993 *Federal Insecticide, Fungicide, and Rodenticide Act* inspection.

A.1.2 Savannah River Site

Site Description. SRS, 19 km (12 mi) south of Aiken, SC, and approximately 26 km (16 mi) southeast of Augusta, GA, occupies 80,130 ha (198,000 acres) of land. Established in 1950, SRS has been involved for more than 40 years in tritium operations and other nuclear material production. Today, the site contains 15 major production, service, research, and development areas, not all of which are in operation at this time. The locations of SRS and its principal facilities are shown in figures A.1.2–1 and A.1.2–2.

The developed areas of the site account for less than 5 percent of the land use and more than 99 percent of the total capital investment. There are more than 3,000 facilities at SRS, including 740 buildings, with approximately 511,000 m^2 (5.5 million ft^2) of floor area.

Major nuclear facilities at SRS include fuel and target fabrication facilities, nuclear material production reactors, chemical separations plants, a uranium fuel processing area, liquid high level waste (HLW) tank farms, a waste vitrification facility, and the Savannah River Technology Center. SRS is in the process of stabilizing and storing various forms of plutonium. This effort, supported by the *F-Canyon Plutonium Solutions Environmental Impact Statement* (DOE/EIS-0219) and the ROD (FR 9824), converts this material to plutonium metal. The process in FB-Line began in November 1995 and the conversion process in F-Canyon was completed in April 1996. The metal product will be stored temporarily in one of the F-Area vaults (FB-Line, 235-F or 247-F). Tritium recycling facilities at SRS empty tritium from expired reservoirs, purify it to eliminate the helium decay product, and fill replacement reservoirs with specification tritium for nuclear stockpile weapons. Filled reservoirs are delivered to Pantex for weapons assembly, or directly to DOD as replacements for expired reservoirs. Historically, DOE has produced tritium at SRS, but has not produced any since 1988.

Tritium recycling operations will continue with the replacement tritium facility conducting the majority of these operations. As part of the nonnuclear consolidation, SRS received some of the tritium processing functions formerly performed at the Mound Plant in Miamisburg, OH.

The current missions at SRS are shown in table 3.2.3–1. These activities can be categorized as DP, Office of Environmental Management (EM), nuclear energy, and other activities.

Defense Program Activities. In the past, the SRS complex produced nuclear materials for DP. This complex consists of five reactors (the C-, K-, L-, P-, and R-Reactors) in addition to a fuel and target fabrication plant, two target and spent nuclear fuel chemical separations plants, a tritium-target processing facility, a heavy-water rework facility, and waste management facilities. The K-Reactor (the last operational reactor) was put into cold standby status in 1992 with no planned provision for restart. SRS is still conducting tritium recycling operations in support of stockpile requirements using tritium recovered from retired weapons as the tritium supply source. Based on the record of decision (ROD) for tritium supply and recycling, issued in December 1995, SRS will continue to perform tritium recycling operations and would be the site for accelerator production of tritium if that technology were selected in the future. In addition, SRS would be the site for a tritium extraction facility to support the commercial reactor option of supplying tritium.

Other Department of Energy Activities. EM is pursuing a 30-year plan to achieve full compliance with all applicable laws, regulations, and agreements; treat, store, and dispose of existing wastes; reduce generation of new wastes; cleanup inactive waste sites; remediate contaminated groundwater; and dispose of surplus facilities.

The Savannah River Technology Center provides technical support to all DOE operations at SRS. In this role, it provides process engineering development to reduce costs, waste generation, and radiation exposure. SRS continues to provide plutonium-238 required to support space programs and has an expanding mission to transfer unique technologies developed at the site to industry. SRS is also an active participant in the Strategic Environmental Research and Development Program formulated to develop technologies to mitigate environmental hazards at DOD and DOE sites.

Non-Department of Energy Activities. There are several facilities and operations at SRS that deal mainly with the ecological elements of the site. These are the Savannah River Forest Station, the

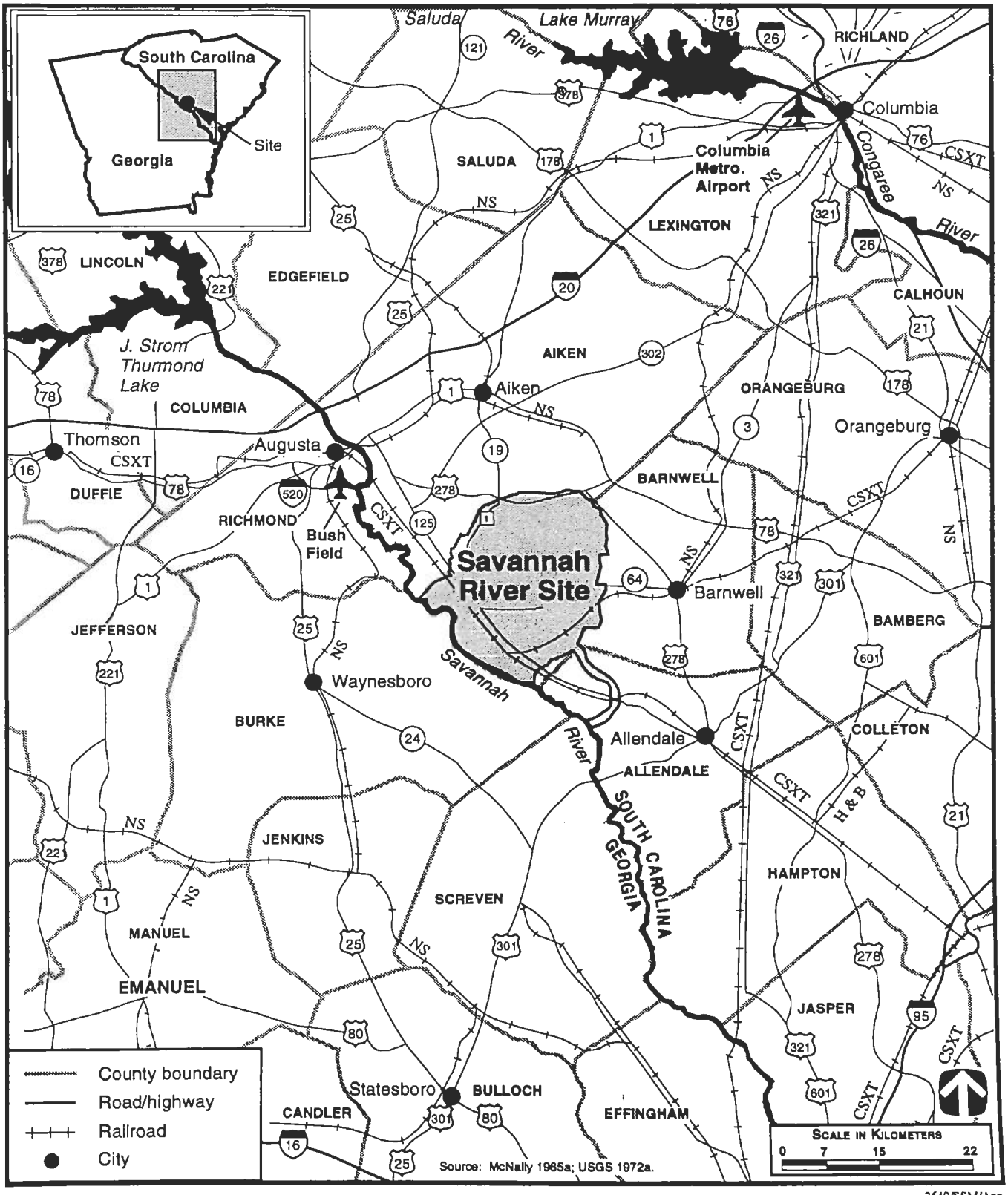

FIGURE A.1.2–1.—*Savannah River Site, South Carolina, and Region.*

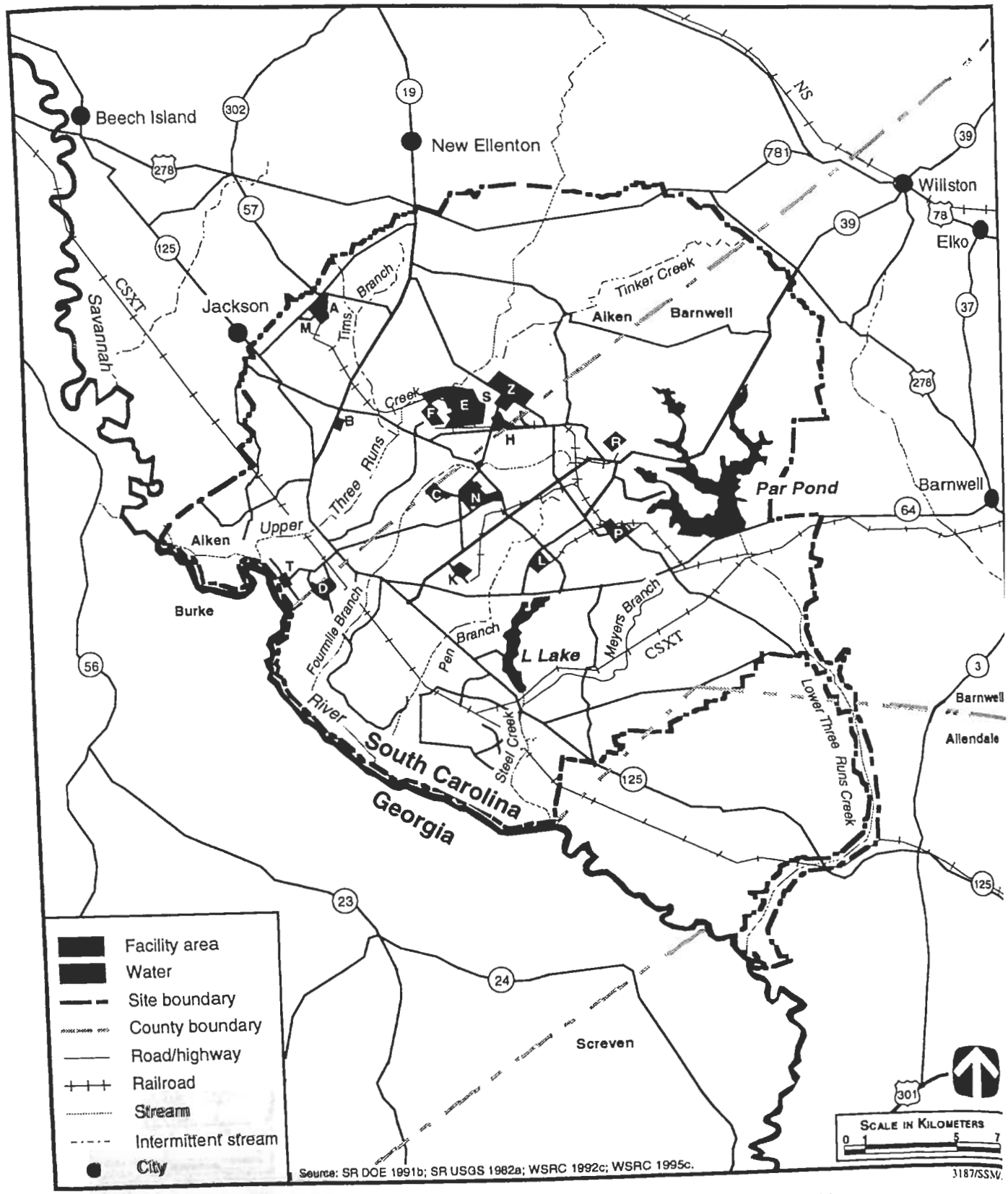

FIGURE A.1.2–2.—*Principal Facility Areas at Savannah River Site.*

Savannah River Ecology Laboratory, the South Carolina Wildlife and Marine Resources Department, the Institute of Archaeology and Anthropology, and the Soil Conservation Service.

Environmental Regulatory Setting. SRS had 544 construction and operating permits in 1993 that specified operating levels for each permitted source (WSRC 1994d:32). Completion of construction in progress and continued operation of permitted facilities are essential to overall SRS operations. Therefore, DOE emphasizes compliance with the terms of these permits as well as with applicable Federal and State of South Carolina environmental regulations and DOE orders related to environmental protection. SRS employed over 1,000 people devoted full-time to protecting the environment through environmental activities in 1993 while accomplishing SRS missions (WSRC 1994d:15). The remainder of this section summarizes the status of SRS compliance with the major environmental regulations.

National Environmental Policy Act. DOE has numerous NEPA documents affecting SRS proposed actions which are in various stages of completion as SRS complies with the requirements of NEPA and Council on Environmental Quality (CEQ) regulations. For example, DOE published the *Savannah River Site Waste Management Final Environmental Impact Statement* (DOE/EIS-0217) in July 1995, which recommended the moderate waste treatment configuration. This configuration would provide a balanced mix of technologies that includes extensive treatment of those waste types that have the greatest potential to adversely affect humans or the environment because of their mobility or toxicity if left untreated, or that would remain dangerously radioactive far into the future. It would provide less extensive treatment of wastes that do not pose great threats to humans or the environment, or that will not remain dangerously radioactive far into the future.

Comprehensive Environmental Response, Compensation, and Liability Act. EPA placed SRS on the NPL effective December 21, 1989. DOE, the South Carolina Department of Health and Environmental Control, and EPA signed a Federal Facility Agreement effective August 16, 1993, to coordinate CERCLA cleanups at SRS, as required by Section 120 of CERCLA. Since the initial listing of the NPL in 1989, SRS has conducted both CERCLA and RCRA cleanup activities under the framework established in the draft Federal Facility Agreement. The comprehensive remediation of SRS will continue as directed by the Federal Facility Agreement currently in place.

Emergency Planning and Community Right-To-Know Act. Each year SRS completes a section 312 annual Tier II inventory report for all hazardous chemicals present at the site in excess of specified quantities and submits it to the South Carolina Department of Health and Environmental Control and to local emergency planning organizations in Aiken, Allendale, and Barnwell Counties, South Carolina. SRS also files an annual toxic release inventory report with EPA based on calculated chemical releases to the environment, which reports aggregate quantities for each regulated chemical that exceeds established threshold amounts. SRS reported eight chemicals to EPA in 1992, with releases totaling 34,820 kilograms (kg) (76,763 pounds [lb]) (WSRC 1994d:19). Changes in facility operating status will lead to changes in chemical inventories and uses of toxic chemicals; the hazardous chemical inventory and toxic release inventory reports will reflect these changes.

Resource Conservation and Recovery Act. The SRS hazardous waste permit was issued in 1987 and modified in 1992. The permit covers storage of wastes at four buildings, treatment at the Consolidated Incineration Facility, and maintenance and groundwater remediation at three closed waste units. Other waste management facilities at SRS are presently operating under interim status. SRS has submitted to the South Carolina Department of Health and Environmental Control a permit application covering the facilities' activities, under which they can continue to operate in conformance with regulatory requirements while applications are reviewed by the regulatory agencies and a final permit decision is issued.

The Federal Facility Compliance Act of 1992. This act is an amendment to RCRA. Westinghouse Savannah River Company submitted a mixed waste inventory report January 13, 1993, and DOE published the complex-wide report, *US DOE Interim Mixed Waste Inventory Reports*, on April 12, 1993. DOE provided this report, and annual and periodic updates since, to state governors and to regulatory agencies in states that host DOE sites, describing its inventory of mixed wastes and treatment capabilities.

To meet requirements established by this act, SRS prepared and submitted a *Proposed Site Treatment Plan* (WSRC-TR-94-0608, May 1995) that sets forth options for treating mixed wastes currently in storage at SRS or that will be generated there over the next 5 years.

Clean Air Act. The air quality control construction permit for the Consolidated Incineration Facility was granted by the South Carolina Department of Health and Environmental Control on November 25, 1992. Emergency power diesel generators are covered under this permit. The M-Area Vendor Treatment facility emergency diesel generator is exempt from permitting requirements because of its limited capacity and expected use. A permitting exemption has been granted for the emergency diesel generator at the replacement HLW evaporator. The SRS NESHAP radionuclide program continues to change to incorporate sampling, monitoring, and dose assessment practices that meet or exceed the requirements of 40 CFR 61, Subpart H. SRS is currently in compliance with CAA requirements.

Clean Water Act. The South Carolina Department of Health and Environmental Control has issued *Clean Water Act* (CWA) permits for the F- and H-Area Tank Farms, Defense Waste Processing Facility, Z-Area Saltstone Facility, replacement HLW evaporator, F- and H-Area Effluent Treatment facilities, and M-Area Liquid Effluent Treatment Facility. Certain discharges from the outfalls at these facilities have been approved. DOE has submitted an industrial wastewater treatment permit application for the M-Area Vendor Treatment Facility. SRS is currently in compliance with CWA requirements.

Safe Drinking Water Act. SRS continues to work toward upgrading the 13 major treatment/distribution systems through which SRS provides drinking water to its employees. The State of South Carolina recommended that SRS consolidate 11 of the 13 major site drinking water systems into three systems. Work is in progress to implement this consolidation. Westinghouse Savannah River Company obtained a construction permit for the water line extension that will serve the Consolidated Incineration Facility.

Toxic Substances Control Act. Disposal of PCBs from SRS is conducted at EPA-approved disposal facilities within the regulatory timeframe. SRS has some PCBs which were radioactively contaminated during a spill in 1978. The act calls for annu disposal of PCB waste, but there is insufficie capacity for disposal of radioactive PCB was offsite. These radioactive PCB materials are sto onsite in a facility that meets storage requirements f up to 1 year. SRS continues to seek disposal techn ogies and facilities that can handle radioactive P(waste.

A.1.3 Kansas City Plant

Site Description. KCP is situated on approximat 57 ha (141 acres) of the 121-ha (300-acre) Banni Federal Complex located within incorporated limits 19 km (12 mi) south of the downtown cente Kansas City, MO. The plant shares the Banni Federal Complex site with other Federal agenc the General Services Administration, the Departr of Defense Finance and Accounting Service, Federal Aviation Administration, the Nati Archives and Records Center, and the Inte Revenue Service, among others. The locations o Bannister Federal Complex and its major facil are shown in figures A.1.3–1 and A.1.3–2.

KCP currently contains approximately 297,00 (3.2 million ft^2) of floor space with approxim 82 percent located within the large Federal and industrial building that dominates the site. and the rest of the Bannister Federal Comple completely developed with limited open spac residential structures are within the Banr Federal Complex. Kansas City has zone Bannister Federal Complex, including KC heavy industrial.

KCP is a Government-owned, contractor-op facility that produces and procures nonnuclea trical, electronic, electromechanical, mech plastic, and nonfissionable metal components DOE nuclear weapons program. In 1992, ther 4,473 people employed at KCP. Site employ expected to decrease to approximately 3,900 year 2000 (KCP 1995a:1). KCP's primary m are shown in table 3.2.4–1.

DP activities comprise the vast majority of tions at KCP. The nuclear weapons-related tions at KCP are production and mainten electrical, mechanical, and plastic product does not process special nuclear materials b have a health physics program consistent wit

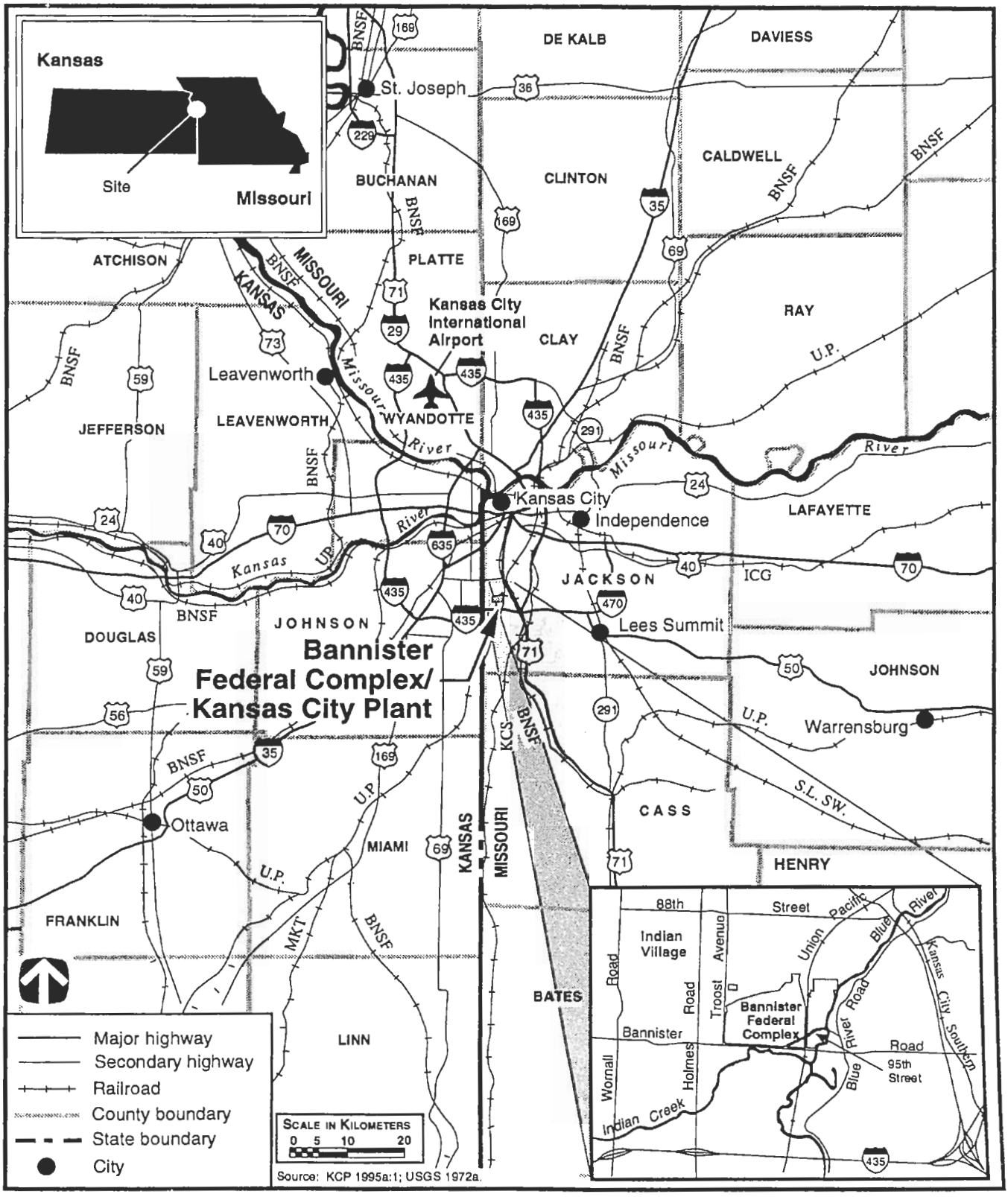

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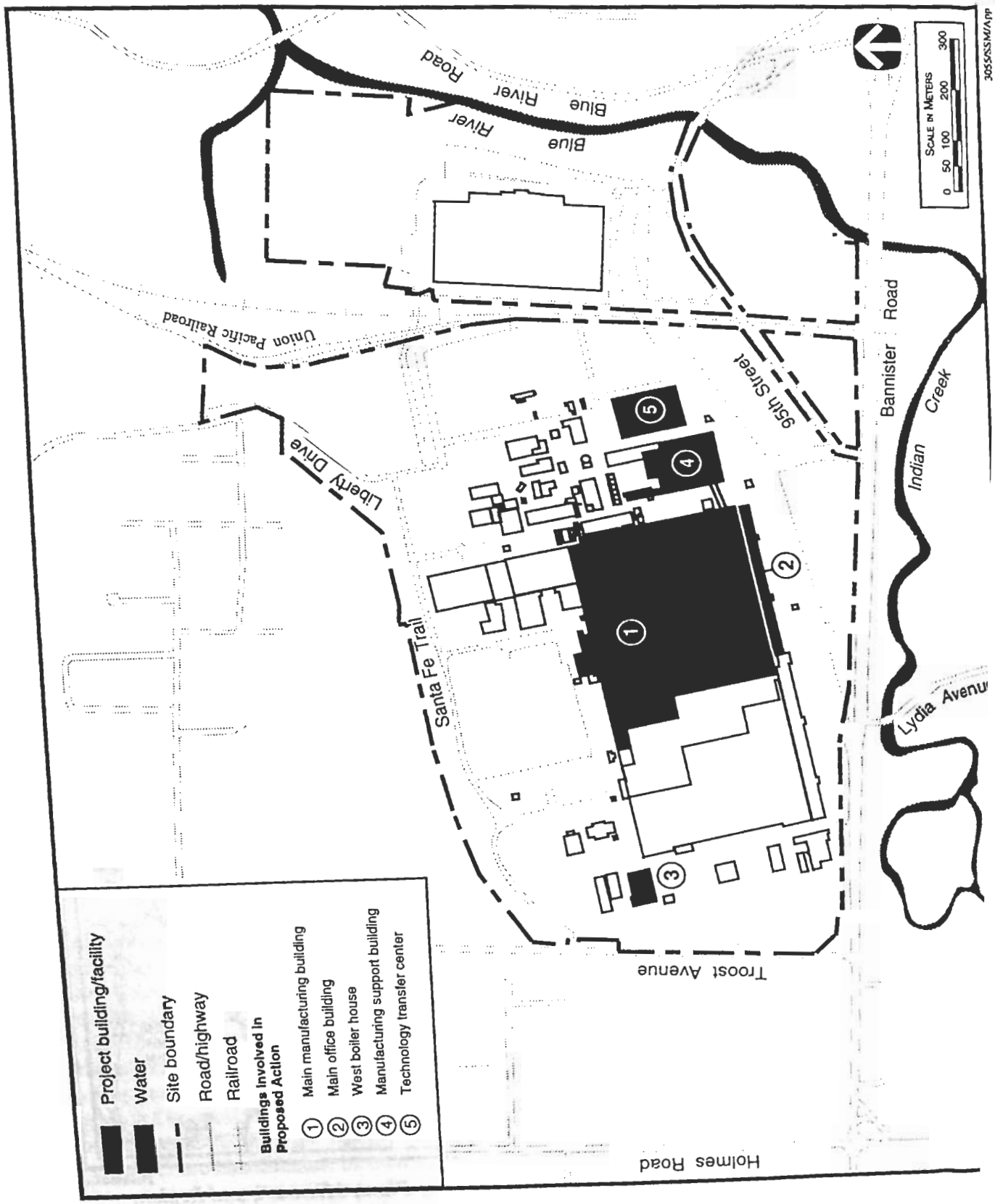
FIGURE A.1.3–1.—*Bannister Federal Complex/Kansas City Plant, Missouri, and Region.*


Blue River Road
Blue River
Union Pacific Railroad
95th Street
Bannister Road
Indian Creek
Liberty Drive
Santa Fe Trail
Troost Avenue
Holmes Road
Lydia Avenue
Scale in Meters
0 50 100 200 300
3055/SSM/App
Project building/facility
Water
Site boundary
Road/highway
Railroad
Buildings Involved in Proposed Action
① Main manufacturing building
② Main office building
③ West boiler house
④ Manufacturing support building
⑤ Technology transfer center

trial radiography and electrical manufacturing. The following is a brief description of KCP mission activities.

Squib Valve Assembly. Pyrotechnic devices that provide valving functions for various nuclear weapons systems are manufactured. Their assembly requires handling Class 1.4 explosives in a static-free environment using fixture-assisted assembly techniques.

Hybrid Microcircuit Assembly. Hybrid microcircuit resistor/conductor networks using alumina oxide substrates with thin-film or thick-film technologies for radars, programmers, timers, and fire sets are manufactured. Their assembly includes attaching electrical components to these networks. This product's assembly requires a Class 10,000 clean room with temperature and humidity controls.

Hybrid Microcircuit Assembly for Joint Test Assemblies. Hybrid microcircuits that consist of an insulating substrate, such as alumina, that contains a thin or thick resistor/conductor network interconnected with active (transistors and integrated circuits) and passive (resistors and capacitors) components that are enclosed in a metal or ceramic package are manufactured.

Microminiature Electrical Assembly. Hybrid microcircuits (semi-conductors packaged in ceramic, leadless chip carriers, transistor outline headers, or kovar [alloy of nickel, cobalt, and iron] flatpacks) are constructed. These products perform several electronic functions in weapons systems such as switches, radars, programmers, fire sets, clocks, and telemetry.

Telemetry Assembly. Telemetry assemblies, neutron detectors, and test component firing systems are manufactured. The telemetry assemblies and neutron detectors provide warhead scoring data in flight tests as part of the joint test assembly. The test component firing systems are high energy transfer systems manufactured for use in underground testing at NTS.

Radar Assembly. Radars used in weapons fuzing systems for bombs and warheads are manufactured. Included in this product line are antenna assemblies that can be an integral part of a radar fuze assembly or a separate component used in the fuzing system. Facility requirements include controlled humidity environment, solvent cleaning stations, and electrostatic control.

Timers, Programmers, and Trajectory Sensing Signal Generators. Trajectory sensing signal generators (electronic assemblies that accept environmental data, verify correctness of that data, and produce predetermined and sequenced output functions for the weapon) are manufactured. The trajectory sensing signal generator product is part of the weapon's nuclear safety system. The primary function is to help ensure that accidental detonation caused by abnormal thermal and shock environments does not occur.

Test Equipment Design and Fabrication. Custom designed and fabricated test equipment able to accept products produced internally and by vendors is produced. This function is capable of performing electrical and mechanical design, producing definition drawings, developing computer software, and fabricating the necessary hardware.

Cellular Silicone and Filled Elastomers. Cellular silicone cushions that are used as filler to cushion components and to allow for thermal expansion are produced.

Foam Molding. Structural foam supports using urethane foam materials are produced.

Syntactic Foam Molding and Plastics Machining. Foam molding that is capable of withstanding higher operating temperatures than conventional foam molding is produced. These products are made using high temperature resins and microspheres, which are sintered in a high temperature oven. Facility requirements include an environmentally controlled (temperature and moisture) plastics machining facility, because of the physical requirements of plastic products.

Laminates and Desiccants. Aluminum silicate desiccant powders and resins used to provide a dry environment in sealed nuclear assemblies and fiber-reinforced plastic laminates are produced.

Noncryptographic Coded Switch Assembly. Electronic devices using hybrid microcircuits and magnetic core memory used to permit the controlled use of nuclear weapons upon proper authorization and to prevent unauthorized use are manufactured.

Strong Link Switch Assembly. Complex electromechanical safety devices used in all modern weapons programs are manufactured. Facility requirements include clean rooms for switch assembly and testing.

Fire Set Assembly. High-voltage circuitry firing systems capable of supplying the energy required to initiate a weapon system are manufactured. Energy is derived from low-voltage battery power and is converted by this system to high voltage and stored until an initiating signal is received. Components include capacitors, inductors, hybrid microcircuits, flat cable and flex circuit technologies, and switches.

Composite Structures. Fiber-reinforced molding resins are manufactured.

Stockpile Support. Components and subsystems removed from the stockpile for reuse, systems testing, or component cycle testing are evaluated. No unique processes, materials, or technologies are used for stockpile support.

Category F Permissive Action Link Electronics Assembly. Electronic assemblies that are part of the nuclear surety system are manufactured.

Special Products-Special Electronics Assembly. This is a restricted access area where electronic products with special security requirements are manufactured.

Cryptographic Coded Switch Assembly. A Permissive Action Link Switch Adapter, an electronic device designed to provide an "electrical block" to the arming switch of the weapon, is assembled. The Permissive Action Link Switch Adapter utilizes both thin- and thick-film hybrid microcircuit technology and is packaged in a foam plastic housing.

T-Gear Containing Cryptographic Keying Material. Cryptographic keying material used to code and recode Permissive Action Link Switch Adapter devices in weapons is manufactured. The presence of these codes prevents unauthorized access to weapons.

MK5 Arming, Fuzing, and Firing Set Assembly. Arming, fuzing, and firing assemblies are assembled. This assembly incorporates a radar, a programmer, an accelerometer, a decelerometer, thermal batteries, a fire set, a contact fuze, and a force balance integrating accelerometer.

B83 Weapon Subassembly. Electronic and mechanical structures are assembled and placed in a case structure with environmental protection. Assemblies provide distance, timing, velocity sensing, velocity control, and electrical power for weapon assemblies.

Machining Technology. This activity provides a wide variety of traditional and nontraditional metal-removing processes, including conventional and numerically controlled turning, milling, drilling, boring, and grinding processes.

Other Mechanical Technology. This activity provides support for mechanical product manufacturing including sheet metal hydroforming, fire edge blanking, punch pressing, riveting, laser marking, threaded insert installation, and manual assembly operations.

Plastics Technology. A wide range of polyurethane foam components, epoxy encapsulants, and modified commercial products for the Complex are manufactured.

Electrical/Electronic Fabrication and Assembly Technology. Printed wiring assemblies used in weapon timers, programmers, trajectory sensing devices, and various other electrical and electronic components are fabricated.

Secondary Support Areas. This activity provides support functions that service nearly all product lines including a broad range of standard industrial processes (e.g., plating, painting, heat treating, welding), some of which are uniquely tailored to meet special weapon requirements.

Environmental Regulatory Setting. KCP has a monitoring system in place to ensure continuity of operations and protection of the environment. Air, surface and groundwater, and air media are regularly sampled and analyzed for various potential pollutants as a part of the ongoing environmental monitoring programs. The monitoring system includes over 40 monitoring wells, 5 sampling points at the ultraviolet/ozone system, 3 ambient air monitoring stations, and sampling results from 4 outfalls, 9 surface water sites, and 1 sanitary discharge. The remainder of this section summarizes the status of KCP's compliance with the major environmental regulations.

National Environmental Policy Act. There are no other major Federal actions under consideration that require NEPA studies and that would affect the plant.

Emergency Planning and Community Right-To-Know Act. The plant prepared and submitted to EPA an annual Toxic Chemical Release Inventory Form (EPA Form R) for 1993 as required under Section 313 of this act.

Resource Conservation and Recovery Act. DOE and EPA signed a Corrective Action Administrative Order on Consent under Section 3008(h) of RCRA on June 23, 1989. The intent of the order is to provide an agreed-upon method of effecting environmental remediation involving solid waste management units at the plant. While the consent order is with EPA, the Missouri Department of Natural Resources maintains RCRA authority over the KCP groundwater monitoring program. Groundwater monitoring has revealed chlorinated solvent contamination, particularly trichloroethylene, in at least three onsite plumes. The city of Kansas City, MO, regulates the discharge permit for the groundwater treatment unit, which is treating the groundwater plumes to preclude release of the contaminant into surface waters offsite.

Comprehensive Environmental Response, Compensation, and Liability Act. KCP is not regulated under this act for any required remediation. Remediation is presently regulated by the provisions of the RCRA Corrective Action Administrative Order on Consent.

Clean Air Act. Overall plant operations are regulated by an annual Air Operating Permit issued by Kansas City, MO. Results of radionuclide monitoring indicate that no radionuclides are present in quantities exceeding background levels. The plant is also in compliance with air pollution requirements for nonradiological air emissions. The plant is working proactively with the city to better define the requirements necessary to obtain the city's approval before constructing a new or modifying an existing source of air pollution, as well as to streamline reporting needs with respect to plant air emissions.

Clean Water Act. Sanitary and industrial wastewater discharges from the plant go into the Publicly Owned Treatment Works and are regulated by Discharge Permit #74; city ordinances administered by the Kansas City, MO, Water and Pollution Control Department; and EPA Pretreatment Standards for the Metal-Finishing Category (40 CFR 433.17). KCP stormwater effluents are regulated by NPDES Permit #MO 0004863, issued by the Missouri Department of Natural Resources.

Safe Drinking Water Act. The drinking water system at the plant meets all conditions for exclusion listed in 40 CFR 141.3, which implements this act. Therefore, the plant does not operate a public water system which is covered by this act.

Toxic Substances Control Act. KCP maintains compliance with the requirements of this act.

Federal Insecticide, Fungicide, and Rodenticide Act. The plant maintains compliance with this act and related state statutes concerning use of pesticides.

A.1.4 Pantex Plant

Site Description. Pantex is located in the panhandle of Texas, in Carson County. It is about 27 km (17 mi) northeast of downtown Amarillo and 64 km (40 mi) southwest of Pampa. The plant is located on a portion of the former Pantex Army Ordnance Plant. Pantex was constructed in the first half of the 1940s by the U.S. Army for the production of conventional ordnance. At the end of World War II, the plant was deactivated and the property eventually reverted to the War Assets Administration. In 1949, the entire installation was sold to Texas Technological College (now Texas Technological University, commonly called Texas Tech) for 1 dollar. The land was to be used for experimental farming, but was subject to recall under the National Security Clause. Following an extensive survey of World War II ordnance plants, Pantex was chosen in 1951 by the Atomic Energy Commission for expansion of its nuclear weapons assembly facilities. The Army Ordnance Corps reclaimed the site for the Atomic Energy Commission and contracted a civilian contractor to rehabilitate it.

DOE owns approximately 3,683 ha (9,100 acres) at Pantex. Just over 809 ha (2,000 acres) of the DOE-owned property are used for industrial operations at Pantex excluding the Burning Ground, firing sites, and other outlying areas. The Burning Ground and firing sites occupy approximately 198 ha (489 acres). Remaining DOE-owned land serves DOE safety and security purposes. DOE also owns a detached piece of property called Pantex Lake,

approximately 4 km (2.5 mi) northeast of the main plant site. This property, comprising 436 ha (1,077 acres), includes the playa lake wetland itself which occupies approximately 138 ha (340 acres). Currently, no Government industrial operations are conducted at the Pantex Lake property. The location of Pantex is shown in figure A.1.4–1.

As of April 1995, approximately 2,599 ha (6,421 acres) of DOE-owned land were being used by Texas Tech for agricultural purposes through a service agreement. The DOE-owned acreage used for agricultural purposes is variable and subject to periodic changes. Adjacent to the 3,683 ha (9,100 acres) owned by DOE, approximately 2,347 ha (5,800 acres) are leased from Texas Tech. DOE use of these lands is primarily for safety and security buffer areas. DOE also leases a small facility at the Amarillo International Airport for its own transportation use.

Pantex industrial operations are conducted for DOE by a management and operating contractor, the U.S. Army Corps of Engineers, and SNL. Seventy-six km (47 mi) of roads exist within Pantex boundaries. A spur of the Burlington Northern Santa Fe Railroad, formerly Atchison Topeka and Santa Fe Railroad, extends through the leased land into the DOE-owned property on the southwest area of the plant site. There are 27 km (17 mi) of railroad tracks within the site boundaries.

Historically, the Pantex site was divided into functional areas commonly called zones. Some maps may still show where the old functional areas were located. The main functional areas are Zone 12, which is the fabrication, assembly/disassembly (A/D), and technical/administrative support area; Zone 11, which is the high explosives (HE) development area; Zone 10, which is an excess property storage site; and Zone 4, which is the weapon/HE magazines and pit storage area. There are other supporting activities in other zones. The locations of Pantex zones are shown in figure A.1.4–2.

All the land within a 5-km (3-mi) radius of the plant site is used for agricultural purposes, either farming or grazing. Approximately 2,000 people live within 8 km (5 mi) of the outside boundary of Pantex. A significant population concentration occurs southwest of the Pantex facility near the Amarillo International Airport and includes the Texas State Technical Institute and the Highland Park Village. Highland Park Village consists of 500 single- and multi-family housing units (duplexes) with an occupancy rate averaging about 90 percent. Approximately 10(students are housed in a Texas State Technica Institute student dormitory.

Plant operation includes direct and support manufac turing operations, management and administrativ services, protective services, and maintenance ar utilities. Current missions at Pantex are shown table 3.2.5–1.

Most operations at Pantex are DP activities. T plant's primary role today is the dismantleme including removal of the fissile material, of reti U.S. nuclear weapons being returned to DOE fr DOD. Other activities include certain maintena and surveillance activities of the remaining nucl weapons stockpile, modification and assembly existing nuclear weapons systems, and productio HE components for nuclear weapons. DOE a conducts quality evaluation of weapons, qua assurance testing of weapons components, research and development (R&D) activities supp ing nuclear weapons at the plant. The principal o ations performed at Pantex are the dismantleme retired nuclear weapons; assembly of nuc weapons from components received from other I facilities; fabrication of chemical HE component nuclear weapons; operation of chemical HE sy sis, and characterization surveillance testing disposal of chemical HE; and maintenance, mod tion, repair, and testing of nuclear weapons co nents. Weapons dismantlement, assembly, stockpile surveillance activities involve handlin nificant quantities of sealed nuclear compor (pits, secondaries, tritium reservoirs), as wel variety of nonradioactive toxic chemicals. descriptions of the above mission activities fol

New production is defined as the final assembl new nuclear weapon to be added to the stoc Pantex receives weapons components and materials from throughout the Complex. Th step in the new production process is mating t main charge subassemblies with the special r materials, which takes place within an assemb Assembly bays house the remainder of the as process. This is where the nuclear subass produced in the assembly cell is built into a co weapon. After final assembly, weapons assen

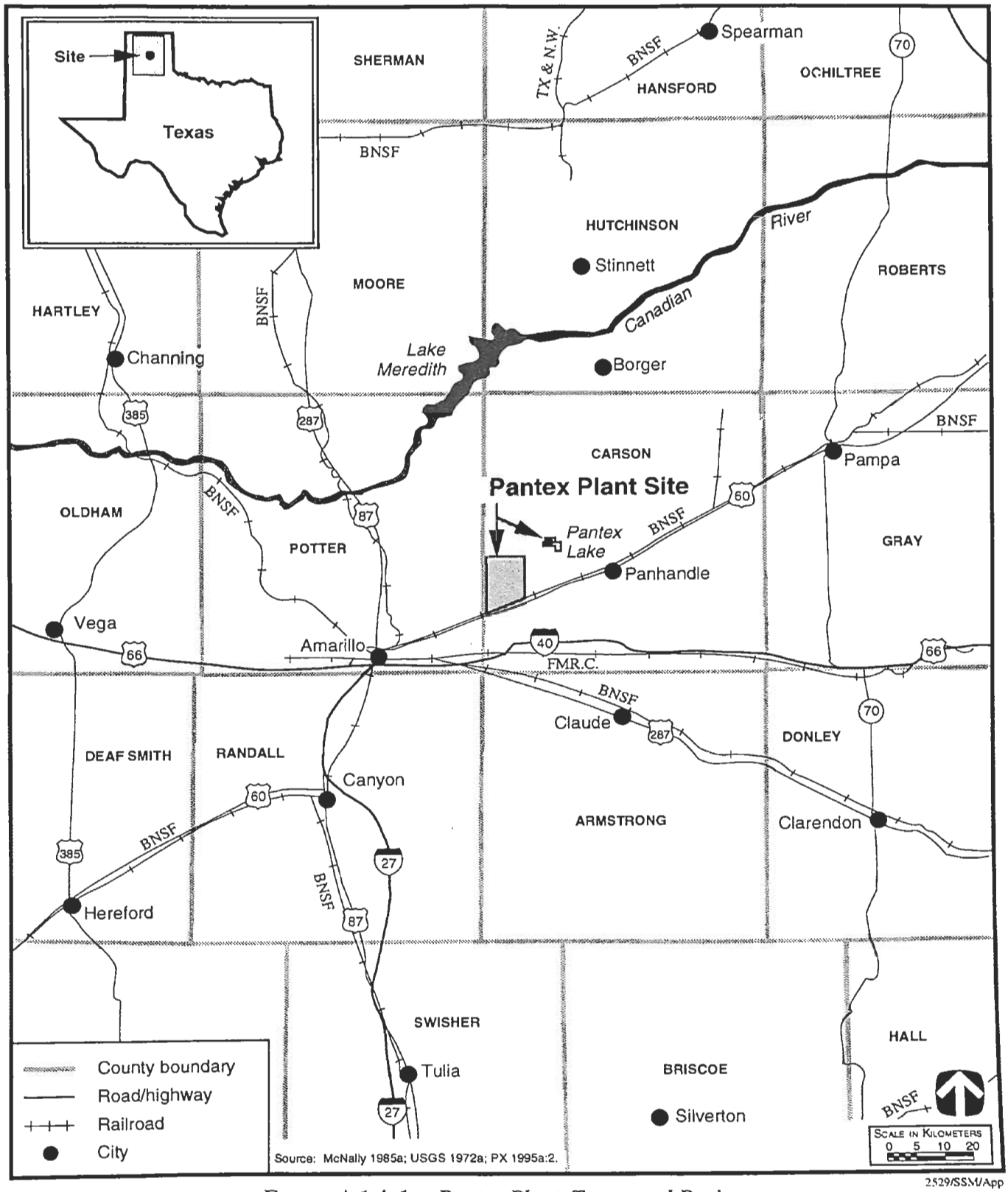


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FIGURE A.1.4–1.—*Pantex Plant, Texas, and Region.*

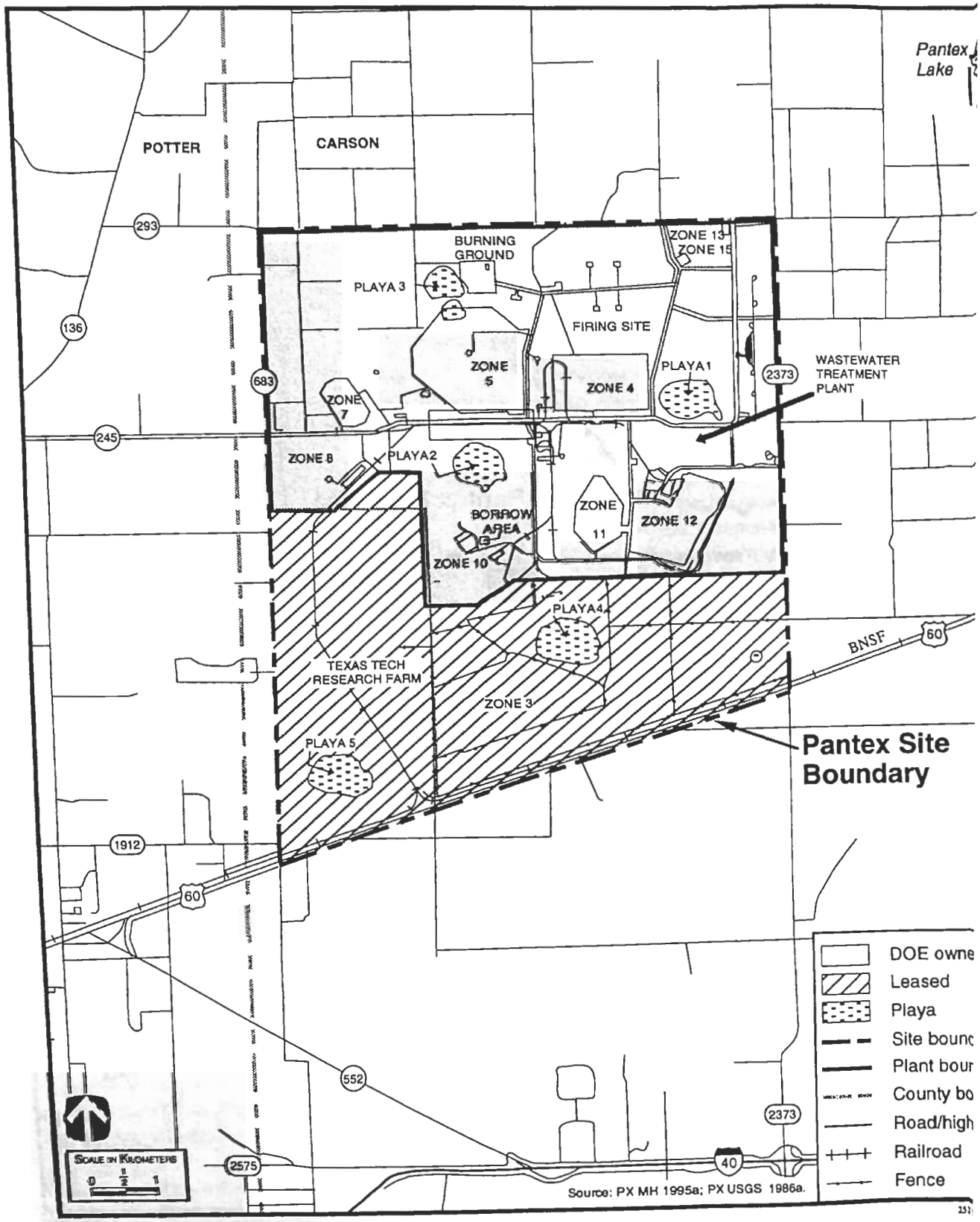

FIGURE A.1.4–2.—*Principal Facilities and Zones at Pantex Plant.*

Pantex are shipped either to other facilities within the Complex or to military facilities. Dismantlement of retired weapons is basically a reversal of the assembly process. All parts must then be properly disposed or stored.

The tasks of modification, maintenance, and repair involve disassembly of a stockpiled nuclear weapon so that one or more components can be repaired, replaced, or modified. After replacing the components, the weapon is reassembled and returned to the stockpile.

HE component production includes manufacturing main charge subassemblies and mock components for use in weapon test assemblies, manufacturing small HE components, producing a variety of explosive materials from chemical reactants and commercially produced explosives, and evaluating explosive materials and components through a variety of analytical, mechanical, and explosive tests.

Pantex performs many quality assurance evaluation activities on both new and stockpiled nuclear weapons. These tests involve disassembly of weapons, laboratory testing of various components, and rebuilding weapons for shipment back to the stockpile. Five evaluations are performed at Pantex: new material laboratory testing, new material flight testing, stockpile laboratory testing, stockpile flight testing, and accelerated environmental aging and materials compatibility testing. These evaluations are outlined below:

- New Material Laboratory Testing—disassembly of a randomly selected, newly produced weapon before it is shipped to the stockpile. Various components are subjected to either destructive or nondestructive tests. After testing, the weapon is rebuilt and shipped to the stockpile.

- New Material Flight Testing—similar to new material laboratory testing. Weapons are selected at random before delivery to the stockpile and assembled into a nonnuclear, explosive joint test assembly for flight testing. These assemblies are tested by DOD aboard aircraft and missiles to verify the functioning of components under in-flight conditions. After the test flight, the joint test assembly is returned to Pantex for further examination when possible.

- Stockpile Laboratory Testing—similar to new material laboratory testing, but stockpile laboratory testing is performed on units randomly selected from the stockpile.

- Stockpile Flight Testing—similar to new material laboratory flight testing, but stockpile flight testing is performed on weapons randomly selected from the stockpile.

- Accelerated Environmental Aging and Materials Compatibility—determines the effects of aging on the integrity of weapons systems over time. These tests involve subjecting newly produced units to an artificial aging process or to environmental stresses to determine whether or not they retain their chemical and physical properties, and to ensure that they will react in a predictable manner after an extended period of time.

Also, some testing is performed at the Gas Analysis Laboratory, which evaluates samples taken from accelerated aging units, material compatibility tests, development activities, material certification tests, and production operations.

In addition to the principal efforts associated with weapons A/D, Pantex provides development support and services to the weapons laboratories and to other government entities.

Pantex contains a number of facilities that stage (temporarily store) weapons components that are destined either for the assembly cells or for shipment to other DOE facilities. Staging procedures may involve the leak testing of staging containers, inventories to verify the number and contents of containers, and unpacking and repacking to physically verify and test contents.

Environmental Regulatory Setting. Pantex conducts operations in compliance with all applicable environmental regulations and statutes and with the requirements of the various permits issued to the plant. The Texas Natural Resources Conservation

Commission has state authority for developing and enforcing regulations and standards for air, water, and waste management. EPA has delegated regulatory authority to the State of Texas for air and solid and hazardous waste. As of December 31, 1994, Pantex is in compliance with the major environmental laws and regulations, with no regulatory enforcement actions or lawsuits pending. The remainder of this section summarizes the status of Pantex compliance with the major environmental regulations.

National Environmental Policy Act. DOE finalized the EA for the *Interim Storage of Plutonium Components* and issued a FONSI in January 1994. This EA analyzed the storage of a larger number of pits for a longer interim period than previously stored. In its FONSI, DOE decided to store no more than 12,000 plutonium pits at Pantex. In May 1994, DOE published a Notice of Intent (NOI) to prepare a new site-wide environmental impact statement (EIS) for *The Continued Operation of the Pantex Plant and Associated Storage of Nuclear Weapon Components*. This Site-Wide EIS incorporates several actions that were ongoing at the onset of this EIS. The draft EIS was issued in March 1996.

Comprehensive Environmental Response, Compensation, and Liability Act. On May 31, 1994, EPA placed Pantex on the NPL effective June 30, 1994 (59 FR 27989) as a Superfund site. As a result, Pantex is subject to the provisions of CERCLA enforcement and is required to develop a Federal Facility Agreement. In August 1994, DOE began discussions with EPA and the State of Texas on this agreement to perform response and remediation activities, pursuant to CERCLA and the National Contingency Plan requirements and consistent with corrective actions currently being performed under RCRA. On December 14, 1994, Pantex hosted a meeting of Federal and state trustees who are responsible for assessing damages for injury to, destruction of, and loss of natural resources. Trustees are continuing to participate in the Natural Resource Damage Assessment process under section 107 of CERCLA.

Emergency Planning and Community Right-To-Know Act. No Toxic Chemical Release Inventory Form (EPA Form R) for 1993 was required under Section 313 of this act, because no reportable substances were released at levels above threshold values. However, in accordance with the Agreement in Principle with the State of Texas that was effec July 31, 1990, DOE provides the state wit chemical and radiological contaminant inventory assessment of the plant.

Resource Conservation and Recovery Act. Pant defined as a large-quantity generator and has permitted and interim-status storage and treat facilities. Pantex manages some solid wastes u Texas Solid Waste Disposal Act Hazardous W Permit Number HW-50284, which includes a co tive action section. Under interim permit st Pantex also operates thermal treatment units fo cessing explosives. Hazardous wastes generat Pantex include, but are not limited to, solvent taminated wastewater and spent organic solvent are contaminated with explosives. These wast either managed onsite by storage and lir treatment or shipped offsite for treatment and di at permitted treatment, storage, and disposal fac

All of the routinely generated radioactive waste Pantex operations is low-level radioactive w This waste is generated in small quantities weapons A/D and consists primarily of ma contaminated with depleted uranium or tr Low-level radioactive waste is temporarily onsite until it is shipped to NTS. Pantex ma mixed waste in accordance with the Pantex *Federal Facility Compliance Act* Compliance while pursuing commercial treatment capabili plan below).

The Federal Facility Compliance Act of 199 act is an amendment to RCRA. DOE publis Interim Mixed Waste Inventory Report in Apr annual updates, and periodic updates since, (ing its inventory of mixed wastes and treatme bilities. Pantex prepared and submitted the Plant *Federal Facility Compliance Act* Com Plan to provide mixed waste treatment capab all mixed waste streams in accordance w *Federal Facility Compliance Act*. This pl approved by the Texas Natural Resources Co tion Commission and adopted through an Order on September 27, 1995. The Agree signed by the state on October 2, 1995, t implementation of this plan.

Clean Water Act. EPA issued Pantex a dra water NPDES permit on December 31

Actions to finalize the draft permit are progressing. Pantex has a stormwater NPDES permit pending, having resubmitted its permit application on August 24, 1994, and submitted NOI, on September 29, 1994. Pantex also has a wastewater no-discharge permit (Number 02296). On April 1, 1993, the state issued a draft permit based on DOE's May 1992 application to change the permit from a no-discharge to a discharge permit. Such a change requires public hearings and the process is continuing.

Safe Drinking Water Act. The plant water supply meets all required primary and secondary drinking water standards and operational and maintenance regulations. A state inspection on October 4, 1994, confirmed that the system is being operated and maintained in compliance with Texas statutes and regulations.

Clean Air Act. Most Federal requirements are implemented in Texas under the *Texas Clean Air Act.* Pantex Plant has permits and standard exemptions issued by EPA and the Texas Natural Resource Conservation Commission. In 1994, Pantex reviewed activities conducted in all buildings to determine their compliance with 40 CFR 61 Subpart A (General Provisions) and Subpart H (Emissions of Radionuclides Other than Radon from DOE Facilities). All buildings were in compliance. At the Burning Ground explosive weapons components, explosive contaminated materials, and explosive waste are thermally treated. The Burning Ground operates under a written Grant of Authority from the State of Texas for its air emissions and under RCRA interim status for its waste management activities. In 1990, Pantex applied to the state to modify its Permit for Industrial Solid Waste Management Site, to include the Burning Ground. The hearing process on the permit modification is continuing.

Toxic Substances Control Act. Pantex is managing PCBs, asbestos, and chemicals in compliance with applicable regulations. For example, waste materials contaminated with PCBs are shipped offsite to permitted facilities for treatment and disposal. As of December 3, 1994, all equipment and parts used at Pantex that contain PCBs have concentrations of less than 50 parts per million (ppm).

Federal Insecticide, Fungicide, and Rodenticide Act. Compliance with this act and several related state statutes, such as the *Texas Pesticide Control Act*, allows agricultural production on the arable land surrounding the plant. Pesticides are applied by state-licensed personnel who ensure the health and safety of workers and protect the integrity of the environment from potential adverse impacts of agricultural chemicals applications.

A.1.5 Los Alamos National Laboratory

Site Description. LANL is located in north-central New Mexico adjacent to the town of Los Alamos (see figure A.1.5–1). It is about 96 km (60 mi) north-northeast of Albuquerque and 40 km (25 mi) northwest of Santa Fe. The area is dominated by the Jemez Mountains to the west and the Sangre de Cristo Mountains to the east. These two ranges flank the Rio Grande Valley, which roughly bisects the state from north to south. LANL is located on the Pajarito Plateau, a volcanic shelf on the eastern slope of the Jemez Mountains, at an approximate elevation of 1,900 to 2,400 m (6,230 to 7,870 ft). Erosion has cut the Pajarito Plateau into a number of steeply sloped, deeply eroded drainage canyons and isolated finger-like mesas that fan out from the west to the east. The laboratory occupies approximately 11,300 ha (28,000 acres); 1,400 ha (3,500 acres) lie in Santa Fe County with the remainder in Los Alamos County.

LANL is divided into 74 Technical Areas (TAs) of which 30 are currently active (see figure A.1.5–2). TA-3 is located on South Mesa and is the main or core area where approximately half of the personnel are located. This area serves as the central technical, administrative, and physical support facility for LANL. It also provides space for experimental, theoretical, and computational sciences. From the core area, four roads connect to the other lab areas. The northern-most road crosses the Los Alamos Canyon and connects with the town of Los Alamos, the airport, medical center, and the Tritium System Test Assembly Facility. The road also provides access down the canyon to a nonoperating research reactor and to the facilities for engineering design of weapons components. The East Jemez Road runs east to the Los Alamos Meson physics facility, a general construction support area, a trailer park, a county landfill, and guard facilities, including a firing range.

From TA-3, Pajarito Road runs southeast to White Rock, the only other housing area near LANL. The TAs in this corridor are used predominantly for

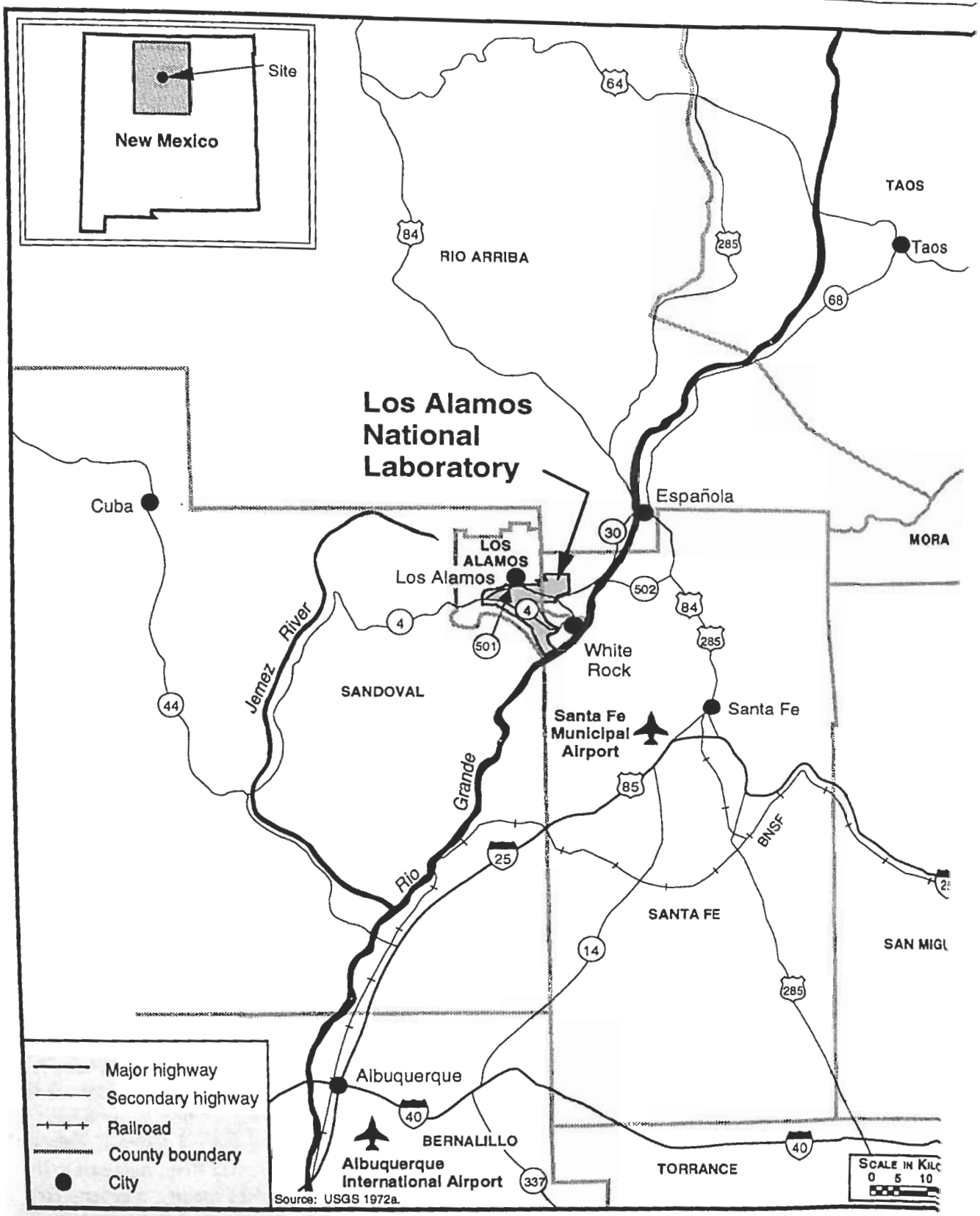

FIGURE A.1.5–1.—*Los Alamos National Laboratory, New Mexico, and Region.*

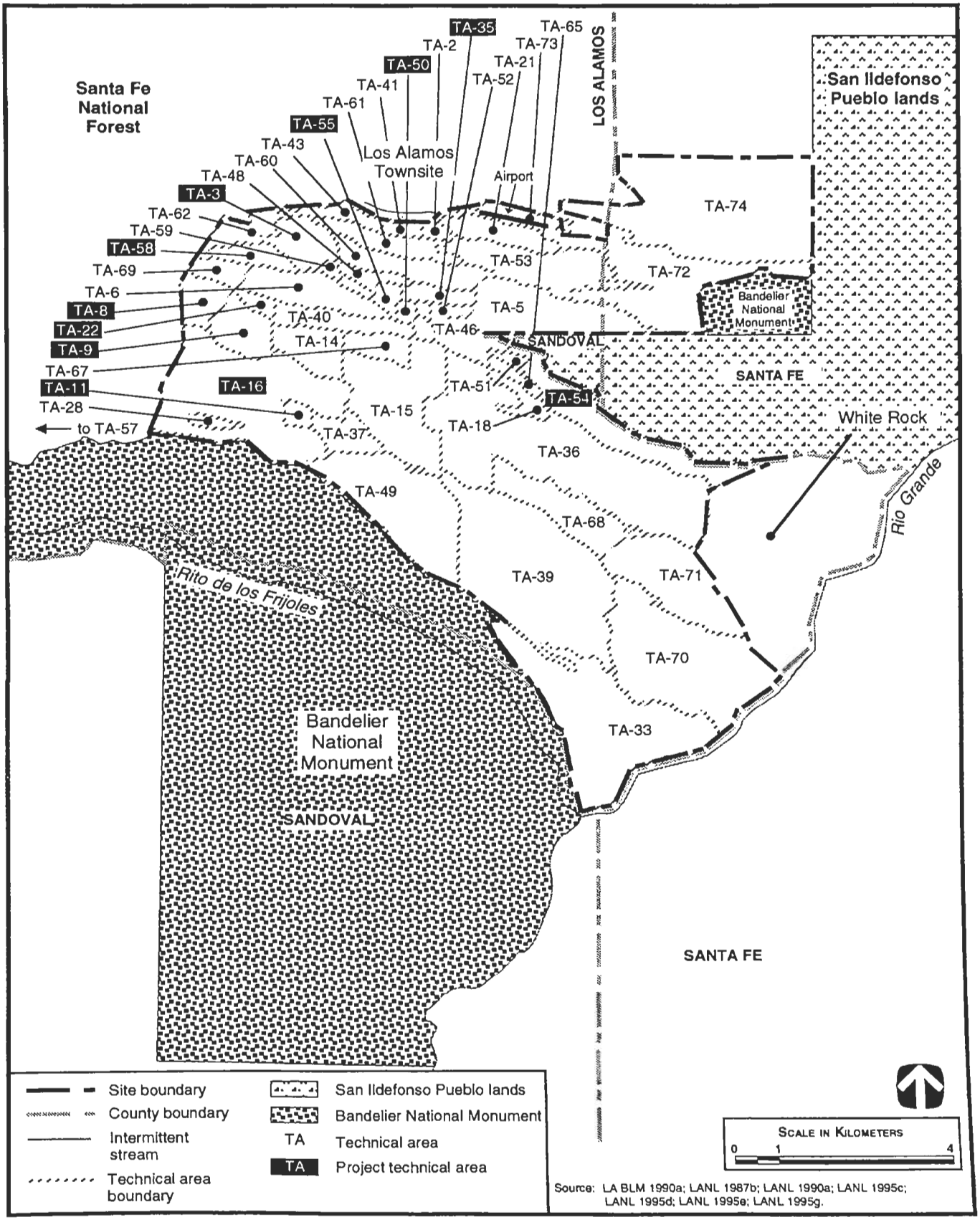

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FIGURE A.1.5–2.—*Technical Areas at Los Alamos National Laboratory.*

nuclear materials R&D, fusion and laser R&D, waste management, and other multiuse experimental sciences. The special nuclear materials, radiochemistry, plutonium processing, and waste management facilities are located in this corridor.

From the core area, West Jemez Road runs south along the western boundary of LANL. This West Jemez Corridor sits atop five mesas. TA-16, one of the larger areas, is dedicated to HE research and research, development, and testing (RD&T). Functions at this site include engineering design, prototype manufacturing, processing, and environmental testing of nuclear warhead systems. Ten other TAs located in this corridor are used extensively by the Dynamic Testing Division. The Aboveground Experiments Division and Design Engineering Divisions also have facilities at TAs within this corridor.

Developed land accounts for approximately 5 percent of the LANL area, 580 of 11,300 ha (1,440 of 28,000 acres). Within this developed area lie 2,318 buildings totaling 756,000 m^2 (8.14 million ft^2). The breakout of this space is as follows: 18 percent for offices, 12 percent for laboratories, 8 percent for heavy experimental facilities, 14 percent for storage, 33 percent for various service facilities, and the remainder for all other uses. Approximately 93 percent of the personnel and square footage are located within 38 of the TAs. About 415 buildings have floor space that exceeds 190 m^2 (2,000 ft^2) and they account for 89 percent of the lab's total floor space. Of these buildings, 152 exceed 930 m^2 (10,000 ft^2) and comprise 75 percent of the total space. The average size of the remaining (approximately 1,903) buildings is 60 m^2 (650 ft^2); half of these buildings are either temporary or transitional. Forty-one percent of all the buildings at LANL are permanent. Of the major buildings (larger than 190 m^2), 73 percent of the total square footage was built prior to 1980.

Current missions at LANL are shown in table 3.2.6–1. **A complete description** of current facility **operations can be found in the Los** Alamos National **Laboratory Institutional Plan.** The major DP facilities **located at LANL are shown in** table A.1.5–1. In addition to the facilities included in this table, DOE operates various smaller facilities related to the ongoing Stockpile Stewardship and Management Program. Many of these have been subject to recent NEPA reviews, but are not included here becau they would be considered minor facilities in relati to the entire Stockpile Stewardship and Managem Program.

Environmental Regulatory Setting. It is the pol of LANL that operations be performed in a man that protects the environment and addresses com ance with applicable Federal and state environme protection regulations. The New Mexico Envi ment Department has state authority for develo regulations and standards for air, water, hazardous and mixed waste management.

The remainder of this section summarizes the s of LANL compliance with the major environm regulations.

National Environmental Policy Act. The cu LANL Site-Wide EIS was published in 1979. the new LANL Site-Wide EIS is under prepar any EA that proceeds ahead of the Site-Wide EI either identified in the NOI (60 FR 25697) of M 1996, or must qualify as an interim action. The Wide Draft EIS is expected to be released public in early February 1997 with the Site- Final EIS to be issued in late August 1997.

Comprehensive Environmental Response, Co sation, and Liability Act. LANL is not on NPL; therefore, cleanup from past operati covered not by CERCLA, but by other regul principally RCRA.

Resource Conservation and Recovery Act. Th was granted authorization by EPA to regulate of hazardous waste under RCRA on Janu 1985, and mixed waste on July 25, 1990. LA large-quantity generator under RCRA and o under both interim status provisions and Mexico Environment Department permit. A tions for mixed waste storage and treatment a were submitted to the state prior to 1992 under interim status provisions.

The state conducts annual RCRA audits of g locations and treatment, storage, and dispos ties throughout the LANL facilities. On Jan 1993, the state issued two Compliance Orde a total of 24 alleged violations, including v involving the management of mixed waste, cies related to general waste management

TABLE A.1.5–1.—*Major Defense Program Facilities Located at Los Alamos National Laboratory*
[Page 1 of 2]

Facility	Function
Chemistry and Metallurgy Research (CMR) Building (TA-3)	Nuclear materials analytical chemistry, R&D, and storage, control and accountability
Main Shops Complex (TA-3)	Nonnuclear and uranium component manufacturing
Sigma Complex (TA-3)	Nonnuclear beryllium and pit support component fabrication, uranium process development and component production, and materials R&D
Nondestructive Testing Facilities Anchor Sites (TA-8)	Radiography, acoustics, and holography
High Explosives Operations, Anchor East (TA-9)	HE storage, characterization, safety and R&D, and pilot scale HE synthesis and formulation
Environmental Testing Facilities, K-Site (TA-11)	Vibration, impact, dynamic testing, and thermal testing
High Explosives Operations, Q-Site (TA-14)	HE testing and disposal
Hydrodynamic Testing Facilities, Pulsed High Energy Radiation Machine Emitting X-Rays (PHERMEX), Dual Axis Radiographic Hydrodynamic Test (DARHT) Facility, Firing Site R-306, and other facilities (TA-15)	Hydrodynamic testing, dynamic experiments, and HE testing
Weapons Engineering Tritium Facility (WETF), S-Site (TA-16)	Tritium processing and recovery, tritium R&D, tritium reservoir loading and surveillance, and fusion and neutron tube target loading
Explosives Facilities, S-Site (TA-16)	Large scale HE formulation, synthesis, casting, pressing, machining, assembly, inspection, packaging, treatment, storage, transportation, and disposal
Los Alamos Critical Experiment Facility (LACEF) (TA-18)	Nuclear criticality studies in design, construction, research, development, and application; nuclear material storage control and accountability
Tritium Operations (TA-21)	Neutron tube target loading and tritium R&D
Detonator Facility (TA-22)	Detonation R&D and high power detonator production
Target Fabrication Facility (TA-35)	Inertial confinement fusion target fabrication, physical and chemical vapor deposition component production and process development, material science R&D, and calorimetry
Trident Laser Facility and other facilities (TA-35)	Inertial confinement fusion experiments and high energy density weapons physics
Pegasus-II Facility and other facilities (TA-35)	Pulsed power capacitor bank, high energy density weapons physics experiments, hydrodynamic experiments, and dynamic material properties research, and pulsed power research
Kappa Site (TA-36)	HE and nonnuclear ordnance testing
Ancho Canyon (TA-39)	Explosively driven pulsed power experiments and development, dynamic experiments, and HE testing
DF Site (TA-40)	Detonation science and HE testing, and detonator development and surveillance
Radiochemistry (TA-48)	Radiochemistry, radiochemistry R&D, isotope production, waste management technology development, and isotope separation
Los Alamos Neutron Science Center (LANSCE) Complex (TA-53)	Neutron spallation sources; neutron research for materials science, stockpile stewardship research and development; nuclear and accelerator research and development; tritium production research and development; research on sub-atomic particles and particle physics, atomic physics, neutrinos, and the chemistry of sub-atomic interactions; isotope production; and radio frequency power sources, high-power microwaves, and free electron lasers studies

TABLE A.1.5–1.—*Major Defense Program Facilities Located at Los Alamos National Laboratory*
[Page 2 of 2]

Facility	Function
Plutonium Facilities (TA-55)	Nuclear material processing and recovery, plutonium R&D, plutonium component fabrication and surveillance, processing of plutonium-238 to produce heat sources, fabrication of ceramic-based and other reactor fuels, nuclear material R&D, and nuclear material storage, control, and accountability

Note: HE - high explosives; R&D - research and development; TA - technical area.
Source: LANL 1995t.

ments, and deficiencies that could adversely affect human health and the environment if not addressed in a timely manner. Negotiations between DOE and the state resulted in a civil penalty of $700,000. All of the deficiencies relating to the general waste management requirements were corrected within 30 days.

The Environmental Restoration Project Office at LANL provides oversight for the closure of several solid waste management units which are subject to the corrective action requirements and closure provisions of the Hazardous and Solid Waste Amendments under RCRA. The state has regulatory authority for closure of these sites. During 1992, LANL and the state were in the process of developing a permit application to initiate the construction of a mixed waste storage and disposal facility for the disposal of mixed waste generated by the site remediation processes. LANL halted all construction efforts for the mixed waste storage and disposal facility in 1995.

LANL operates a controlled air incinerator that was permitted in November 1989 for the treatment of hazardous waste. The facility was placed on standby in 1992 for upgrades. The controlled air incinerator will be closed under RCRA and TSCA by the end of 1996.

The Federal Facility Compliance Act of 1992. This Act is an amendment to RCRA. DOE published the *Interim Mixed Waste Inventory Report* in April 1993 and has published annual updates and periodic updates since, describing its inventory of mixed wastes and treatment capabilities. The New Mexico Environment Department issued a Compliance Order in October 1995 directing DOE to implement the LANL Site Treatment Plan for Mixed Waste. This order terminates the Federal Facilities Compliance Agreement between DOE and EPA concerning land disposal restricted wastes.

Clean Water Act. The NPDES permit for L regulates discharges from 9 wastewater treat facilities and 130 industrial outfalls. During compliance for sanitary and industrial discharge 99.6 percent and 99.0 percent, respectively. NOIs for stormwater discharges were submitt October 1, 1992, for the Lagoon Elimination I and the Los Alamos Integrated Communi System. An additional NOI was submitt September 29, 1992, for stormwater discharge ciated with industrial activities.

Safe Drinking Water Act. LANL maintains (ance with *Safe Drinking Water Act* (SDWA) st for its public water systems.

Clean Air Act. The New Mexico State Impl tion Plan incorporates requirements of including the 1990 CAA Amendments, Nl National Ambient Air Quality Standards, a Source Performance Standards. The state adr these Federal and state requirements through of Air Quality Control Regulations. Duri two open burn permits were issued to LAN burning of scrap wood from experiments burning of jet fuel for ordnance testing.

LANL operated 36 continuous emissions m stations in 1992 to sample air discharges fo tive releases. While no radionuclide conc were detected which would pose an enviro health problem, EPA issued a Notice of N ance on November 23, 1992, following a LANL's NESHAP program in August 1 notice stated that LANL emissions exc 10 mrem/yr effective dose equivalent stand the 1990 reporting period. As a result of t of Noncompliance issued to DOE by EP on November 27, 1991, and November DOE and EPA entered into negotiations

compliance with NESHAPs. The negotiations resulted in a Federal Facilities Compliance Agreement being signed on June 13, 1996, which requires that compliance with Subpart H be achieved by August 15, 1996.

Toxic Substances Control Act. This act regulates PCB use and storage at LANL. In compliance with TSCA regulations, equipment and materials containing PCBs greater than, or equal to, 50 ppm are removed and shipped offsite to permitted treatment and disposal facilities or disposed of at TA-54, Area G (only applied to solids containing 50 to 499 ppm of PCBs). No deficiencies were noted following an EPA inspection during the summer of 1993.

Federal Insecticide, Fungicide, and Rodenticide Act. In addition to this act, LANL is regulated by the *New Mexico Pest Control Act* which regulates pesticide use, storage, and certifications. Annual inspections to assess compliance with this act are conducted by the state.

A.1.6 Lawrence Livermore National Laboratory

Site Description. LLNL is located in southern Alameda County, CA, approximately 64 km (40 mi) east of San Francisco. The LLNL complex consists of a main site east of the city of Livermore (Livermore Site), several leased properties near the Livermore Site, and a more remote site (Site 300) in the Altamont Hills, 27 km (17 mi) southeast of the Livermore Site (see figures A.1.6–1 and A.1.6–2).

The Livermore Site occupies a 332-ha (821-acre) area in the southeast portion of the Livermore Valley. The valley is about 26-km (16-mi) long (east-west) and 11- to 16-km (7- to 10-mi) wide (north-south). Hills ranging in elevation from 300 to 600 m (1,000 to 2,000 ft) surround the Livermore Valley. These hills are predominantly open space devoted to agriculture and recreation uses.

Onsite land use includes offices, laboratory buildings, support facilities (e.g., cafeterias, storage areas, maintenance yards, facilities for waste treatment and groundwater treatment, security, and a fire station), roadways, parking areas, and landscaping. A 150 m (500 ft) wide security buffer zone lies along the northern and western borders of the site.

The Livermore Site has approximately 550,000 m^2 (5.9 million ft^2) of facilities that include existing space and areas under construction. This space is distributed among approximately 600 buildings, over 300 are temporary structures. Temporary facilities (trailers, modular buildings, and World War II buildings) constitute 30 percent of the occupied space and house approximately 51 percent of the total laboratory office population. Approximately 53 percent of the permanent facilities are more than 20 years old; 40 percent are more than 30 years old.

East of the laboratory is agricultural property with a few scattered rural residents. A branch of the California Aqueduct, the South Bay Aqueduct, traverses land east of the lab in a north-south direction. To the north lies a light industrial park, a line of the Union Pacific Railroad, and Interstate 580. Residential areas of low to medium density and the city of Livermore extend to the west. Immediately south of the Livermore site is the SNL site at Livermore. Farther south, and southwest, the land is cultivated for vineyards.

Site 300 is an HE test site occupying 2,800 ha (7,000 acres) of largely undeveloped steep ridges and canyons about 29 km (18 mi) southeast of Livermore in the sparsely populated Altamont Hills of the Diablo Range. Elevations vary from a low of 150 m (500 ft) along Corral Hollow Creek on the southern boundary to 520 m (1,700 ft) above mean sea level in the northwest portions of the site. Slopes range from 8 to greater than 45 degrees.

Site 300 consists of two remote firing areas supported by a chemistry processing area and an administrative support area at the site entrance. The site also includes a number of storage magazines. Major buildings include the firing complex, the advanced test accelerator, the dynamic test complex, disassembly complex, and drop tower test areas. Other facilities include police and fire department, badge office, HE storage, warehouse, medical, cafeteria, and other service facilities. There are approximately 31,700 m^2 (341,000 ft^2) of facilities, including four trailers.

While the majority of the land surrounding Site 300 is agricultural (primarily for grazing cattle and sheep), two other defense-related research and testing facilities are in the area. A facility adjacent to Site 300 on the east and a similar facility approxi-

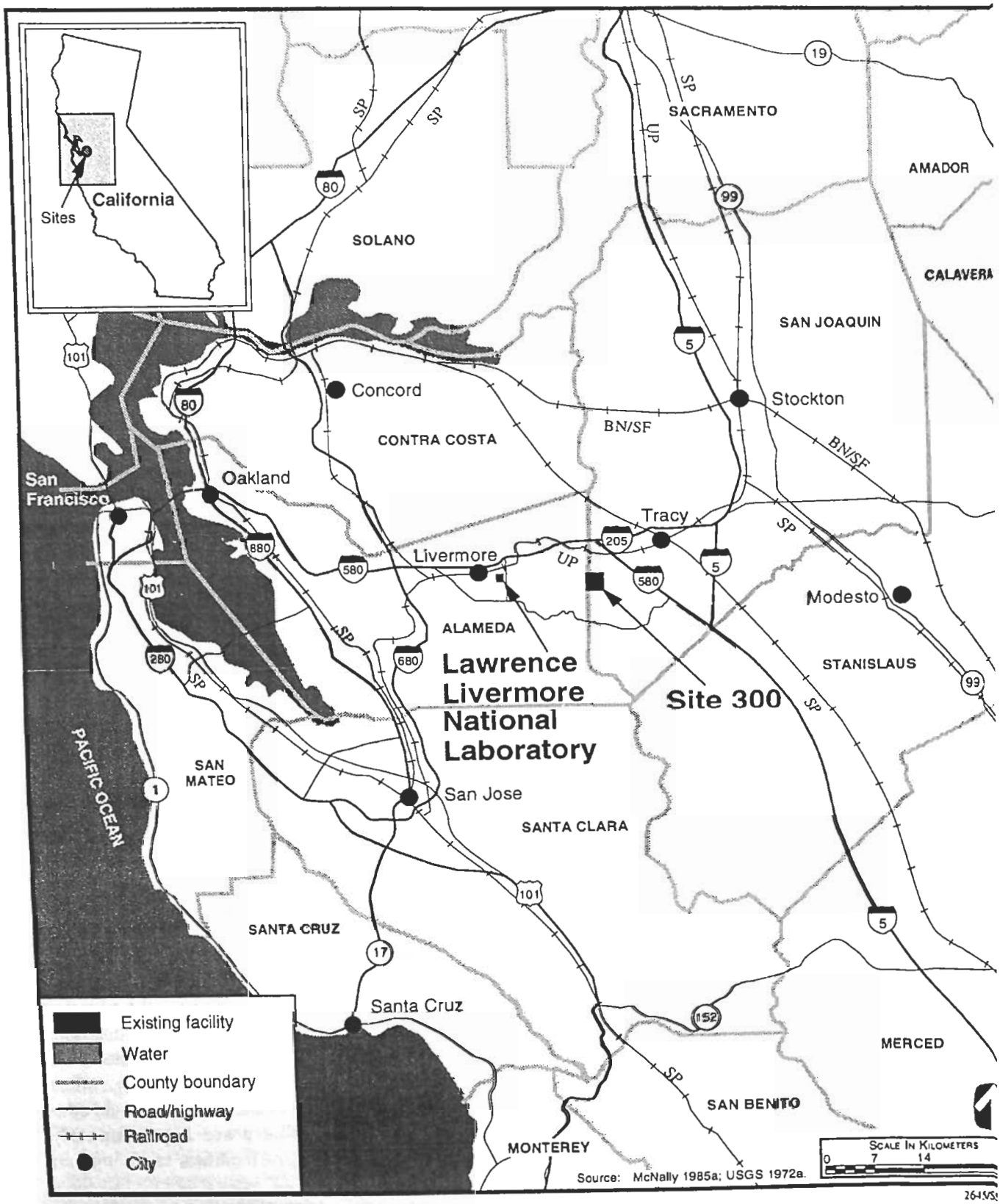


FIGURE A.1.6–1.—*Lawrence Livermore National Laboratory, Livermore Site and Site 300, California, and Region.*

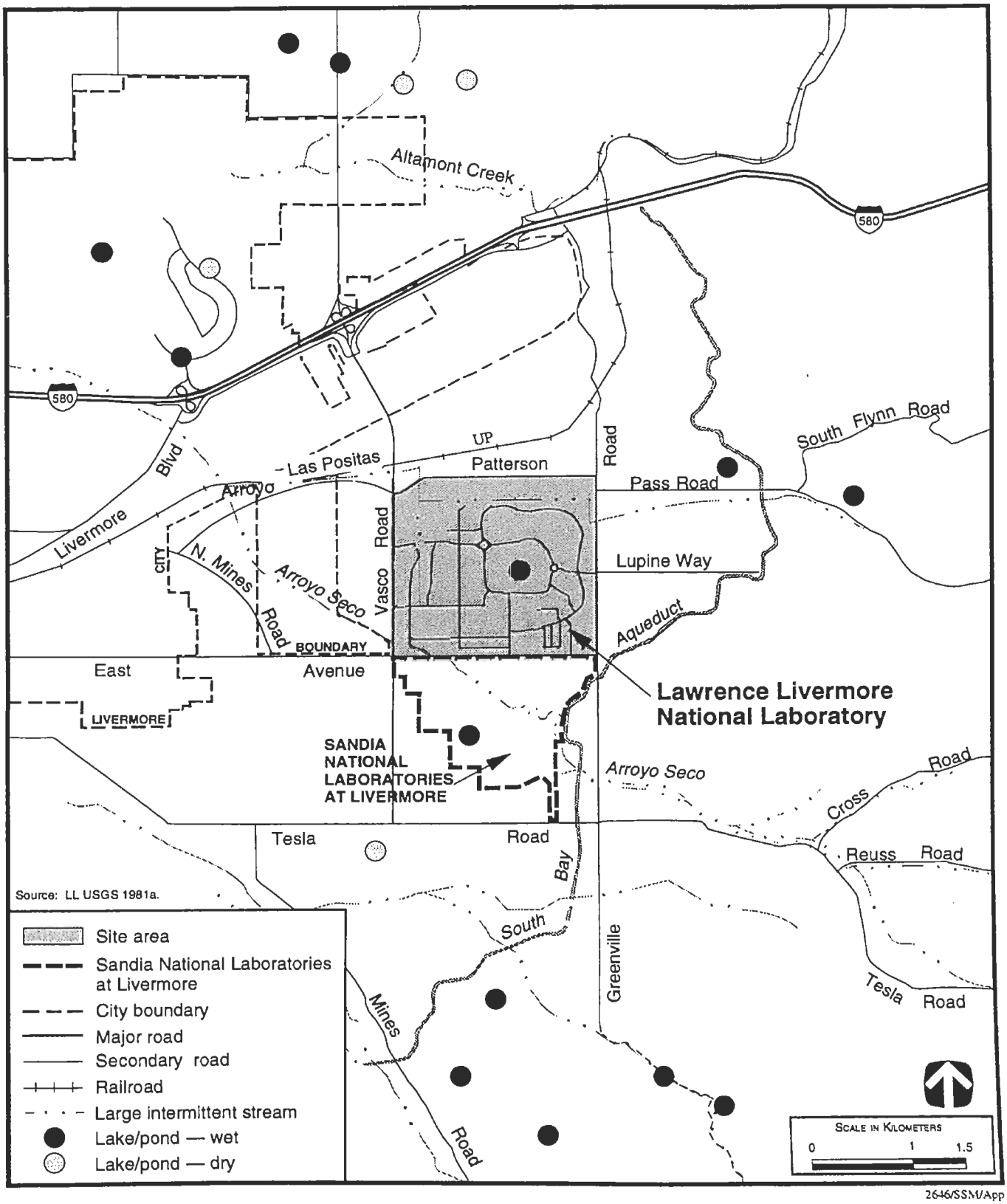


FIGURE A.1.6–2.—*Lawrence Livermore National Laboratory, Livermore Site, and Vicinity.*

ately 1 km (0.6 mi) to the south both conduct HE sts.

outh of the western portion of Site 300 is the arnegie State Vehicular Recreation Area which is for ie exclusive use of off-highway vehicles. The earest urban area is the city of Tracy, approximately 3 km (8 mi) northeast of Site 300. Several rural residences, however, are much closer to the site. Power-enerating wind turbines occupy the land northwest of he site.

Current missions at LLNL are shown in table 3.2.7–1. A complete description of current facility operations can be found in the Lawrence Livermore National Laboratory Site Institutional Plan. The major DP facilities located at LLNL are shown in table A.1.6–1.

Environmental Regulatory Setting. It is the policy of LLNL to protect the environment and ensure that operations are conducted in accordance with applicable laws and regulations that have been enacted to protect the environment. With some minor exceptions, the State of California has regulatory authority for air, water, solid waste, hazardous waste, and mixed waste as administered through a variety of state and local agencies. The remainder of this appendix section summarizes the status of LLNL compliance with the major environmental regulations.

National Environmental Policy Act. During 1994, two EAs for proposed projects were initiated by LLNL. The *Draft Environmental Assessment for the Mixed Waste Management Facility* addressed the potential impacts from construction and operations of a facility that will demonstrate potential technologies for treating DOE mixed waste on a pilot scale. Based on the results of this research, certain technologies may be adopted later by DOE for treatment of mixed wastes throughout DOE's facilities. DOE is currently reviewing this Draft EA.

The Draft EA for the Site 300 Explosives Waste Treatment Facility addressed the potential impacts of constructing and operating up-to-date replacement facilities for treating explosives wastes and explosives-contaminated wastes at Site 300. DOE is currently reviewing this Draft EA.

The *California Environmental Quality Act* (California Public Resources Code Sections 21000 et seq.) establishes state policy for protecting environmental quality. The goals of the *California Environmental Quality Act* are achieved by requiring local and state agencies to assess the potential environmental impacts of proposed actions for which they may have a decisionmaking role. This is done through the preparation of an initial study, which leads to issuance of a negative declaration or a requirement to prepare an Environmental Impact Report. An Environmental

TABLE A.1.6–1.—*Major Defense Program Facilities at Lawrence Livermore National Laboratory*

Facility	Functions
Microfabrication Laboratory, Bldg. 153	Microelectronics fabrication
High Explosives Application Facility (HEAF), Bldg. 191	High explosives research with modern diagnostic and testing equipment
High Pressure - High Temperature Laboratory, Bldg. 232	High pressure - high temperature thermodynamic and materials properties experiments
Hydrogen Research Facility, Bldg. 331	Inertial confinement, fusion-directed, experimental work with isotopes of hydrogen gas, metal hydrides in contained beds, and small amounts of experimental metal hydrides and tritium-labeled compounds
Plutonium Facility, Bldg. 332	Testing plutonium-bearing engineering assemblies, developing and demonstrating improved plutonium fabrication techniques, and fundamental and applied research in plutonium metallurgy
High Pressure Laboratory, Bldg. 343	Tests and experiments with high pressure systems
Inertial Confinement Fusion Laser Facility, Bldg. 391	Nova laser, high-energy-density physics
Hydrodynamic Test Facilities with Flash X-Ray Facility at Site 300	Hydrodynamic and explosives testing with gamma-ray implosion imagery and other diagnostics

Source: LLNL 1995a.

Impact Report may also be prepared directly for projects that may have significant environmental impacts. No Initial Study or Environmental Impact Report documents were prepared by the University of California in 1994 on proposed projects for which the university was the decisionmaking or lead agency.

Comprehensive Environmental Response, Compensation, and Liability Act. Both the Livermore Site and Site 300 are listed on the EPA's NPL. The Livermore site was placed on the NPL in 1987, and LLNL's groundwater project complies with provisions specified in a 1988 Federal Facility Compliance Agreement entered into by EPA, DOE, the California Department of Toxic Substances Control, and the San Francisco Bay Regional Water Quality Control Board. The ROD was issued by EPA in 1992. Remedial investigations and treatment operations are ongoing.

Groundwater investigations began at Site 300 in 1981. The site was placed on the NPL in 1990. In June 1992, DOE negotiated a Federal Facility Agreement with EPA and the state that describes the groundwater and soil investigations to be conducted and specifies the reporting dates. Since June 1992, Site 300 investigations and remedial actions have been conducted under the joint oversight of EPA, Central Valley Regional Water Quality Control Board, and the Department of Toxic Substances Control under the authority of a Federal Facility Agreement.

Emergency Planning and Community Right-To-Know Act. In compliance with this act, LLNL implemented a computerized chemical tracking system called ChemTrack. The system allows for improved emergency response planning and complete inventory information, as well as improved overall chemical management.

Resource Conservation and Recovery Act. RCRA-regulated operations at LLNL's Livermore Site are managed under Interim Status Standards as administered by the California Department of Toxic Substances Control. A Part B Permit application has been submitted and describes storage and treatment operations at five facilities located in and near Buildings 233, 419, 514, 612, and 693. An additional new storage and treatment facility known as the Decontamination and Waste Treatment Facility would include construction of five new buildings for waste management operations to be located in the vicinity of Building 693. The Decontamination and Waste Treatment Facility would replace the majority of existing waste management facilities located in Areas 612 and 514.

At Site 300, LLNL operates a Part B-permitted container storage unit (Building 883) for management of hazardous waste. This facility permit is currently undergoing renewal. Explosives wastes are burned at an open burn facility near Building 829 under terms of a compliance order until a new thermal treatment unit can be designed, permitted, and constructed at which time the Building 829 facility will close. Part B Permit applications have all been submitted to the California Department of Toxic Substances Control for a new explosives storage facility and a new open burn/open detonation facility.

The Department of Toxic Substance Control conducted its annual audit of generator locations throughout the Livermore Site from June 22 to 25, 1993, and on July 14, 1993. Seventeen alleged violations were reported August 6, 1993. Site 300 was inspected February 16 and 17, 1993, and November 15 and 16, 1993. In each case, three violations were noted. Appropriate actions were taken at both sites to correct the violations.

The Building 829 Open Burn Facility thermally treats HE waste. The facility operates in accordance with interim status standard and the terms of a September 1993 compliance order. Design and permitting activities are currently in progress to build a new waste treatment facility at Building 845 to eliminate the need for the Building 829 Open Burn Facility. Another new facility has been proposed for Site 300, and a Part B Permit application has been submitted. The facility is an explosives waste storage facility that augments the storage capability at Building 883 by providing a separate dedicated facility to store explosives waste.

Federal Facility Compliance Act of 1992. Mixed wastes are generated and managed by LLNL operations in accordance with requirements of the *Federal Facility Compliance Act*. Existing and proposed management practices have been identified in the proposed site treatment plan submitted in April 1995. DOE is negotiating terms of a compliance agreement with the California Department of Toxic Substances Control.

Clean Water Act. This act is administered by the California Resources Board and regional and local agencies. Routine discharges to ground and surface waters resulting from the groundwater investigation and remediation activities at the Livermore Site are subject to permits issued by the San Francisco Bay Regional Water Quality Control Board. Stormwater associated with industrial activities is discharged under a Wastewater Discharge Permit issued by the Livermore Water Reclamation Plant. Site 300 holds water discharge requirements and NPDES permits issued by the Central Valley Regional Water Quality Control Board. These pertain to discharges associated with cooling towers and groundwater remediation work. Site 300 permits are also in effect for closed landfills and operation of an explosives rinsewater surface impoundment system.

Safe Drinking Water Act. LLNL maintains compliance with SDWA standards for its public water systems.

Clean Air Act. This act is enforced by the California Air Resources Board and local districts. The Livermore Site complies with the Bay Area Air Quality Management District rules and regulations. Site 300 is subject to rules enforced by the San Joaquin Valley Unified Air Pollution Control District. LLNL holds over 200 permits for air pollution sources and control equipment that are renewed on an annual basis.

Radionuclide emissions are regulated under NESHAPs, which is administered by EPA. In April 1994, EPA notified DOE and LLNL that all requirements of the August 1993 Federal Facilities Compliance Agreement had been met and that LLNL had satisfactorily demonstrated compliance.

Toxic Substances Control Act. LLNL regulates PCBs and asbestos in compliance with TSCA regulations. LLNL submits annual PCB reports to EPA. Asbestos wastes are reported in the hazardous waste report.

A.1.7 Sandia National Laboratories

Site Description. SNL is headquartered in Bernalillo County at the foot of the Manzano Mountains adjacent to Albuquerque, NM. At their nearest points, SNL facilities are 4.0 km (2.5 mi) south of Interstate 40 and 10.5 km (6.5 mi) east of downtown Albuquerque. The facilities are surrounded by Kirtland Air Force Base, with co-use agreements on some U.S. Air Force property. An area of the Manzano Mountains east of Kirtland Air Force Base has been withdrawn from the U.S. Forest Service for the exclusive use of the Air Force and DOE. The location of SNL and its principal facilities are shown in figures A.1.7–1 and A.1.7–2.

The laboratory is situated on the 30,562-ha (75,520-acre) Kirtland Air Force Base military reservation. Kirtland Air Force Base is located on two broad mesas bisected by the Tijeras Arroyo, an east/west canyon. These mesas are bounded by the Manzano Mountains (Cibola National Forest) to the east and the Rio Grande to the west. Elevations range from 1,500 m (4,921 ft) at the Rio Grande to 3,255 (10,680 ft) at Sandia Crest, which is in the Sandia Mountains adjacent to Albuquerque.

Albuquerque, the largest population center in Bernalillo County, and also the closest population center to Kirtland Air Force Base, is located slightly north of the base. The 1990 census figures show an Albuquerque population of 384,736. The Isleta Indian Pueblo, which borders Kirtland Air Force Base on the south, is the next nearest population center with a 1990 census of 2,953. An estimated total population of 578,313 people live within an 80-km (50-mi) radius of Kirtland Air Force Base. This includes permanent residents of Kirtland Air Force Base living in the base housing areas. Current missions at SNL are shown in table 3.2.8–1. A description of facility operations can be found in the Sandia National Laboratories Institutional Plan. The major DP facilities located at SNL are shown in table A.1.7–1.

The majority of activities at SNL are DP activities. SNL facilities are located in five technical areas and several additional test areas. There are approximately 560 major buildings totaling over 370,000 m^2 (4 million ft^2) located in these areas. Each area has its own distinctive operations and is described in the following paragraphs.

Technical Area I has the largest employee population (approximately 5,000) and is dedicated primarily to three activities: the design, research, and development of weapons systems; limited production of weapons system components; and energy programs. Technical Area I includes the main library, offices, laboratories, and shops used by administrative

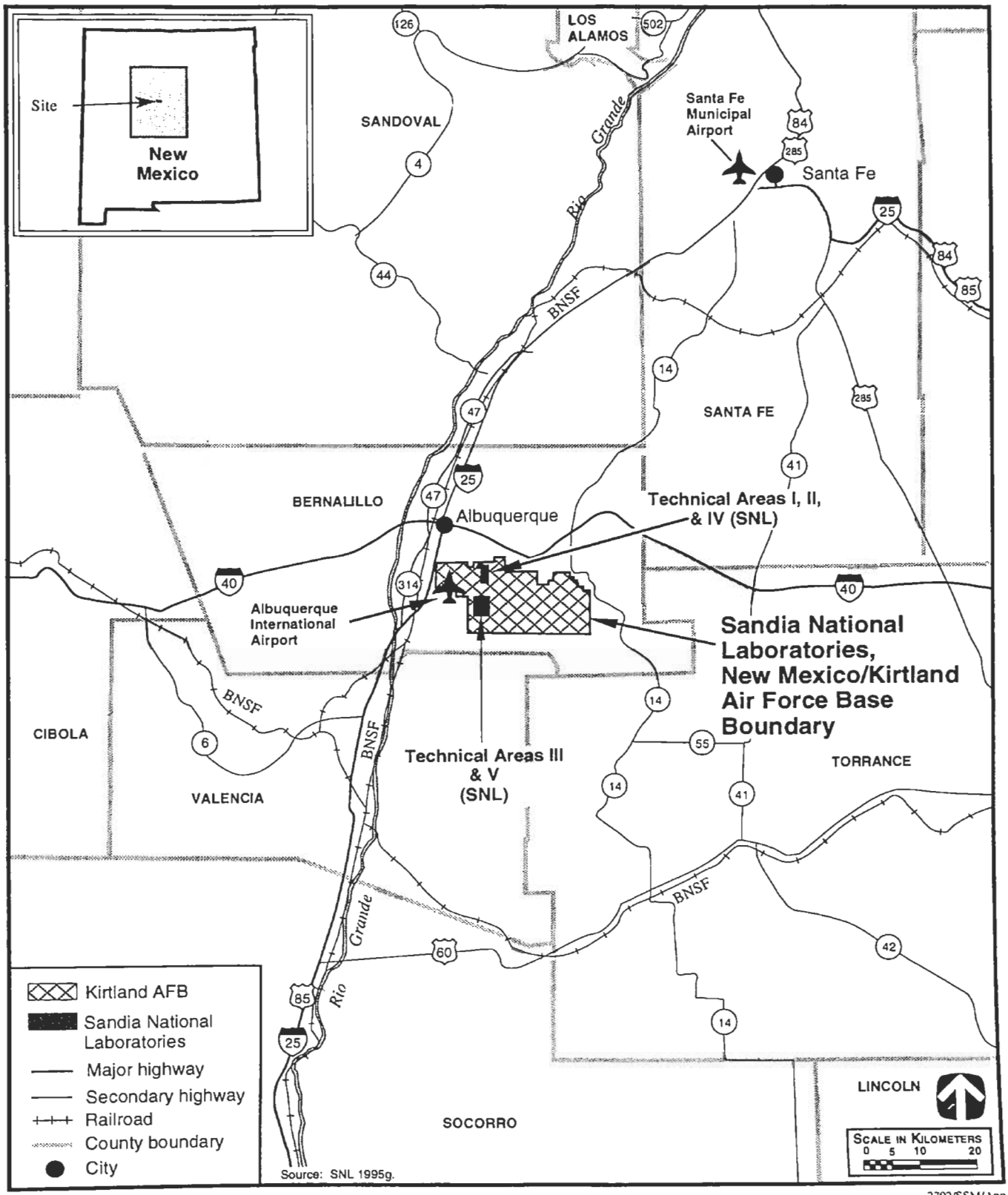


FIGURE A.1.7–1.—*Sandia National Laboratories, New Mexico, and Region.*

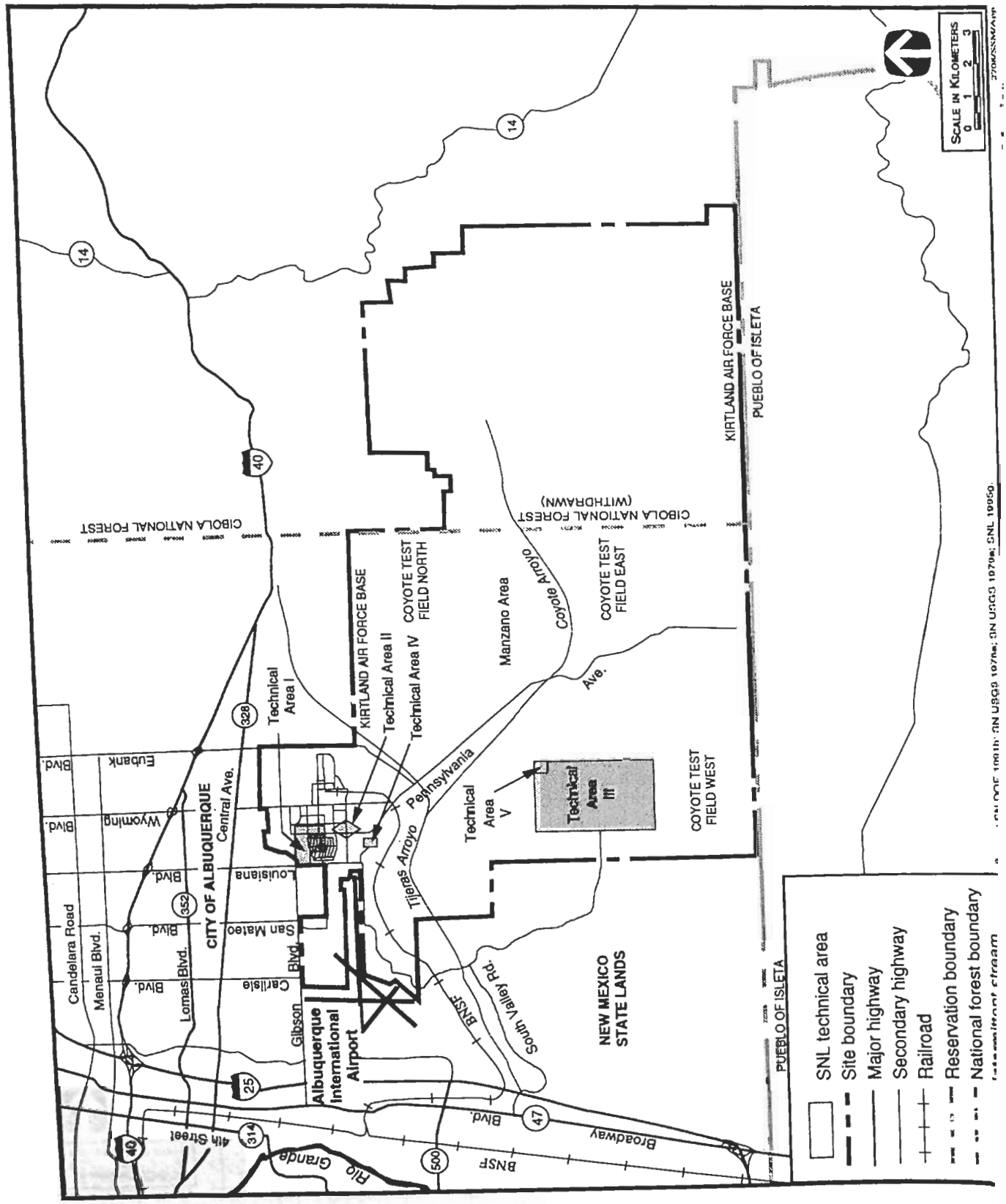

SCALE IN KILOMETERS
0 1 2 3
KIRTLAND AIR FORCE BASE
PUEBLO OF ISLETA
CIBOLA NATIONAL FOREST
CIBOLA NATIONAL FOREST (WITHDRAWN)
COYOTE TEST FIELD NORTH
COYOTE TEST FIELD EAST
COYOTE TEST FIELD WEST
Technical Area I
Technical Area II
Technical Area III
Technical Area IV
Technical Area V
Manzano Area
Coyote Arroyo
Tijeras Arroyo
Pennsylvania Ave.
CITY OF ALBUQUERQUE
Central Ave.
Eubank Blvd.
Wyoming Blvd.
Louisiana Blvd.
San Mateo Blvd.
Carlisle Blvd.
Gibson Blvd.
Lomas Blvd.
Menaul Blvd.
Candelaria Road
Albuquerque International Airport
BNSF
South Valley Rd.
NEW MEXICO STATE LANDS
Broadway Blvd.
Rio Grande
4th Street
SNL technical area
Site boundary
Major highway
Secondary highway
Railroad
Reservation boundary
National forest boundary

TABLE A.1.7–1.—*Major Defense Program Facilities Located at Sandia National Laboratories*

Facility	Function
Lurance Canyon Burn Site and Explosive, Electro-Explosive, and Aerial Cable Test Facilities (Coyote Test Field)	Weapons component testing in simulated accident scenarios and constrained rocket testing
Neutron Generator Facility, Wind Turbine, Environmental Test Laboratories, and Chemical, Ion, and Laser Physics Laboratories, Integrated Materials Research Laboratory, Micro Electronics Laboratory, Robotics, Manufacturing Science and Engineering Laboratory, Advanced Manufacturing Processes Laboratory, Primary Standards Laboratory, Lightning Test Laboratory, A/D Laboratory (Technical Area I)	Design, test, and manufacture of neutron generator components and weapon systems supporting R&D and production; structural analysis in high fatigue environments and material properties research
Explosives Component Facility, Device Development and Testing Facilities, and Environmental Testing Laboratories (Technical Area II)	Design, test, and manufacture of low power detonators, initiators, and timers for weapons subsystems
Dynamic Shock, Airgun Test and Reentry Burn-Up Test Facilities, Drop Tower, and Molten Core Laboratory (Technical Area III)	Extreme environmental testing, product acceptance qualification testing, material properties determination, and melting and casting process research
Particle Beam Fusion Accelerator (PBFA) High-Energy Radiation Megavolt Electron Source (HERMES) III Accelerator, Saturn Accelerator (Technical Area IV)	High energy gamma ray testing of electronic components for survivability; pulse power and weapon physics R&D; short pulse gamma and x-ray test facility for weapons component radiation testing
Hot Cell Facility, Annular Core Research Reactor, Sandia Pulse Reactor III, Gamma Irradiation Facility (Technical Area V)	Research and surveillance test facility for highly radioactive materials and products; high power pulse or steady state neutron and gamma ray radiation simulation environment for weapons component testing; steady state gamma ray testing of electronic systems and subsystems

Source: SNL 1995i.

technical staff; two small accelerators; a foundry; a steam plant; and an emergency diesel generator plant.

Technical Area II is a small area used for explosives testing. Techniques for measuring fractures in geologic strata are developed at this facility. Also located in Technical Area II are an inactive low-level radioactive waste disposal site, a small radioactive material decontamination and storage facility (Building 906), and a storage facility designed to temporarily hold PCB-contaminated materials to be transported to an EPA-licensed disposal facility. The inactive low-level waste (LLW) disposal site has not been used for over 20 years. Most Technical Area II activities have been transferred to the Explosive Components Facility, a new facility intended to replace Technical Area II. This facility will integrate many of the existing Technical Area II activities, as well as some remote testing activities currently performed in other test areas.

Technical Area III is located adjacent to and south of Technical Area V, 8 km (5 mi) south of Technical Area I. It comprises 20 test facilities that include extensive environmental test facilities (such as sled tracks, centrifuges, and a radiant heat facility). Other facilities in Technical Area III include a paper incinerator, an inactive LLW and mixed waste disposal site, and a melting and solidification laboratory. The inactive radioactive waste disposal site in Technical Area III consists of two adjoining fenced areas that occupy 0.6 ha (1.5 acres). One area was used for LLW disposal in seven shallow trenches. The second area was used for disposal of classified LLW in 37 pits. LLW consisted primarily of tritium-contaminated materials. Three additional pits located in the classified waste disposal area were used exclusively for natural and depleted uranium waste disposal. The site is currently used as an interim storage facility for radioactive and mixed wastes.

An inactive hazardous-waste disposal and storage site is also located near the southern boundary of Technical Area III. This facility has not been used for disposal of hazardous wastes since November 7, 1985. It was used as an interim hazardous waste storage area from 1985 to 1988. A closure plan and post-closure permit application were prepared in May 1988. The newer hazardous waste repackaging and storage building, located south of Technical Area I, has been in use since 1988.

Technical Area IV consists of several inertial-confinement fusion research and pulsed-power research facilities. One large accelerator, the Particle-Beam Fusion Accelerator-II, was completed in 1985. A large accelerator facility, the Simulation Technology Laboratory, houses seven pulsed-power accelerators. Several of these accelerators have been transferred from Technical Area V.

Technical Area V houses two research reactors in two reactor facilities, an intense gamma irradiation facility (using cobalt-60 and cesium-137), and a hot cell facility. The two research reactor facilities in Technical Area V are small and quite dissimilar: the Sandia Pulsed Reactor is an unreflected, unmoderated assembly of enriched uranium, and the Annular Core Research Reactor consists of an annular core of 226 fuel elements in an open water tank.

There are also test areas outside the five Technical Areas. These areas are located south of Technical Area III and in canyons on the west side of the Manzano Mountains. Coyote Canyon and Thunder Range are two examples of such areas.

Depleted uranium was used in the past for explosive testing in these remote areas. The test areas were surveyed following each test and contaminated materials were collected and disposed of in accordance with DOE requirements. Environmental monitoring is done as necessary. Operations in these areas are administratively controlled to avoid uranium contamination to public areas beyond the confines of Kirtland Air Force Base.

Electricity is supplied to SNL and much of southeast Albuquerque through the Public Service Company of New Mexico's switching station on Eubank Boulevard. Voltage is stepped down through transformers to 46 kilovolt (kV) for distribution through four feeders. Feeder 1 serves Technical Areas II through V and outlying areas, Feeder 2 serves the Radiant Heat Facility in Technical Area III, and Feeders 3 and 4 supply Technical Area I.

Kirtland Air Force Base is responsible for the overall natural gas system. The distribution system in technical areas I, II, and IV is owned by DOE and operated by SNL. Natural gas is purchased from Kirtland Air Force Base, which buys it commercially. Fuel is stored in Technical Area I for refueling remote-site tanks and for emergency supply to the steam plant. The steam plant in Technical Area I supplies steam both to that area and to Kirtland Air Force Base for space heating, hot water converters absorption chillers, and processes.

Responsibility for water storage and transmissio rests with Kirtland Air Force Base, with SNL handling distribution only to its own facilities Remote test areas in Coyote Canyon have wate trucked to them.

SNL is responsible for the sewage collection syste in its technical areas and in Coyote Test Field, whi Kirtland Air Force Base is responsible for the bas wide system. SNL contains over 24 km (15 mi) sewer lines interconnected with Kirtland Air For Base. Technical Areas I and IV are tied into t Kirtland Air Force Base system, while Technic Areas II, III, and V and Coyote Test Field have sep tanks and sewage lagoons independent of the m system.

Environmental Regulatory Setting. SNL strive comply with environmental and other requirem established by Federal, state, and local statutes regulations, executive orders, and DOE orders. New Mexico Environment Department has s authority for developing regulations and stand for water, and hazardous and mixed waste man ment. The Albuquerque/Bernalillo County Quality Control Board has authority for develc regulations and standards for air. The remaind this section summarizes the status of SNL co ance with the major environmental regulations.

National Environmental Policy Act. During SNL NEPA compliance activities focused on c oping the SNL NEPA program and baseline inf tion and fulfilling commitments made in the *Action Plan to Tiger Team.* SNL initiated the ration of 15 EAs during 1994. FONSIs were

for the neutron generator/switch tube prototyping relocation on April 8, 1994; general-purpose heat source safety verification testing on February 15, 1995; and the construction and occupancy of the Robotic Manufacturing Science and Engineering Laboratory on April 13, 1994.

Comprehensive Environmental Response, Compensation, and Liability Act. Based on the Preliminary Assessment/Site Inspection conducted in 1988, EPA concluded that none of SNL's inactive waste sites qualified for the EPA's list of high-priority cleanups. Therefore, this act does not govern waste site cleanup, but RCRA does. During 1994, SNL had two reportable quantity chemical releases. Lead was released during a scheduled rocket motor firing and transformer oil leaked from an oil storage system and escaped from the system's secondary containment.

Resource Conservation and Recovery Act. The New Mexico Environment Department was granted authorization to regulate control of hazardous waste under RCRA by EPA on January 25, 1985, and mixed waste on July 25, 1990. SNL, which operates an onsite permitted treatment facility, is defined by RCRA as a large-quantity generator. During 1994, 86,369 kg (190,400 lb) of RCRA-regulated hazardous waste was managed by SNL. On May 12, 1994, DOE transmitted a Class I permit modification of the RCRA storage permit to the New Mexico Environment Department, allowing SNL to receive offsite generated wastes. SNL also operates a Thermal Treatment Facility that was permitted in November 1994 for the treatment of residual explosives.

The New Mexico Environment Department conducts annual RCRA audits of the SNL Hazardous Waste Management Facility and generator locations throughout SNL facilities. On October 7, 1994, the New Mexico Environment Department issued a Compliance Order listing 17 alleged violations, including open containers of hazardous waste, labeling errors, and incomplete training. Five of the violations were dropped following negotiations between SNL and the New Mexico Environment Department, and a civil penalty of $9,240,000 was proposed in January 1995. All of the remaining issues have been corrected.

As identified by the Environmental Restoration Project, potential release sites are being evaluated and corrected. At SNL's inactive Chemical Waste Landfill, concentrations of trichloroethylene slightly above the EPA's drinking water standards were discovered in groundwater 150 m (500 ft) beneath the site. A corrective action plan, entitled *The Chemical Waste Landfill Final Closure Plan and Postclosure Permit Application,* was approved by the New Mexico Environment Department in May 1993. Sites at which assessment efforts continued during 1994 include the Mixed Waste Landfill, Technical Area II, the Liquid Waste Disposal System, Tijeras Arroyo, and also at the Kauai Test Facility in Hawaii.

The Federal Facility Compliance Act of 1992. In accordance with the *Federal Facility Compliance Act* enacted in October 1992, SNL submitted a complete inventory of its mixed waste in November 1993 for the Final Mixed Waste Inventory Report. Additionally, SNL submitted the Conceptual Site Treatment Plan (Phase I) for SNL mixed waste issued in October 1993 and the Draft Site Treatment Plan (Phase II) issued in August 1994 to the New Mexico Environment Department. In December 1994, the Proposed Site Treatment Plan (Phase III), including a revised mixed waste inventory through September 1994 and preferred treatment options in accordance with the DOE/AL Mixed Waste Treatment Plan (April 1994), were submitted to the New Mexico Environment Department.

Clean Water Act. SNL submitted an NPDES permit application on October 1, 1992, for its industrial discharge. Two NOIs to discharge for construction of stormwater discharges were submitted on January 24, 1994, for construction of the Technology Support Center, and on September 19, 1994, for construction of the Robotic Manufacturing Science and Engineering Laboratory. SNL has six wastewater discharge permits from the city of Albuquerque.

Safe Drinking Water Act. SNL maintains compliance with SDWA standards for its public water systems.

Clean Air Act. SNL is regulated by the 1990 CAA amendments and by local regulations, including air quality control regulations, which are administered by the Albuquerque/Bernalillo County Air Quality Control Board. In 1994, 15 open burn permits were issued to SNL by the city of Albuquerque. Permits were issued for operations at the Luance Canyon Burn Site, the Thermal Treatment Facility, the Coyote Test Field, and the Fire Extinguisher Training

Site. All other existing permits were issued by either the city of Albuquerque or EPA. In early 1995, SNL conducted an inventory of hazardous chemical usage. The inventory included radionuclides, ozone-depleting substances, and chemicals listed in *Superfund Amendments and Reauthorization Act*, Section 313, Toxic Chemical List.

In January 1994, SNL began an ambient air surveillance program which included one criteria pollutant monitoring station, seven particulate matter monitoring stations, and four VOC monitoring locations. No exceedances or violations were detected in 1994.

Toxic Substances Control Act. SNL regulates PCBs and asbestos in compliance with TSCA regulations. Electrical distribution equipment containing greater than, or equal to, 50 ppm are being removed and shipped offsite to permitted treatment and disposal facilities. A total of 49 items, having PCB concentrations over 50 ppm, remained in service as of December 31, 1994. SNL operates two programs for the management of asbestos. The Facilities Asbestos Program manages the abatement of floor tiles and insulation. The Non-Facilities Asbestos Program handles nonfacilities items that may contain asbestos such as gloves, fume hoods, and ovens.

Federal Insecticide, Fungicide, and Rodenticide Act. EPA-registered pesticides are applied by EPA-certified applicators. Records including pesticide types and quantities and Material Safety Data Sheets are retained by SNL.

A.1.8 Nevada Test Site

Site Description. NTS is located in Nye County, NV, and encompasses approximately 351,000 ha (867,000 acres). It varies in width from 45 to 56 km (28 to 35 mi) east to west and in length from 64 to 88 km (40 to 55 mi) north to south. To the north, east, and west, the rugged, mountainous, and undeveloped Federal-owned land masses of the Nellis Air Force Range provide a buffer zone, varying from 24- to 104-km (15- to 65-mi) wide, between the test areas and public lands. The Bureau of Land Management manages the land that borders the southern and southwestern boundaries. U.S. Highway 95 and the town of Amargosa Valley are also to the south. The southeast corner of NTS is about 104 km (65 mi) northwest of Las Vegas. Locations of NTS and its principal facilities and testing areas are shown in figures A.1.8–1 and A.1.8–2.

NTS is unique in that it is a large open area with tightly controlled access and with adequate infrastructure to handle and run tests with hazardous or radioactive materials. Approximately 25 percent of NTS is undeveloped or provides buffer zones for ongoing programs and projects. Facility expansions are possible within all areas and encroachment from land development is not a concern.

NTS is divided into numbered test areas to simplify the distribution, use, and control of resources. Th main entrance and the Desert Rock Airstrip are at th southeast corner of the site (Area 22). Mercury Bas Camp is adjacent in Area 23 and provides administra tive operations and general support. Offices fo DOE, DOD, the Defense Nuclear Agency, LLNL LANL, SNL, and all of the supporting contractors these organizations are located in this area. Dorm tory, cafeteria, recreation, and transportation faci ties are located here.

North of Mercury is Frenchman Flat (Area 5) historic area because of the atmospheric nuclear te conducted there. Just north of Frenchman Flat is A 6. The Control Point One Complex, which provi control over and execution of nuclear detonation NTS, is located here, as is a new work-camp for c struction and craft support. A shallow, usu dry-lake bed, Yucca Lake, is also in this area. Far north is the broad valley of Yucca Flat, site of mar the more recent nuclear tests (Areas 1, 2, 3, 4, 7, 9 10). At the northern edge of this flat at the ba Rainier Mesa is the center of DOD/Defense Nu Agency activities (Area 12). The Area 12 C which is closed, provided logistic, service, and ac istration facilities that, in busier times, supporte northern part of NTS. The Area 12 Camp pro ready access to the Defense Nuclear Agency tu mined into the face of Rainier Mesa. In the nort section of NTS is Pahute Mesa. Pahute M geology allows its use for testing nuclear device larger yields (Areas 19 and 20).

Due to its large size, the perimeter of NTS is no pletely fenced; however, roving security p patrol the test site. Security and hazardous ar fenced and some areas are protected with guards and electronic security measures. (

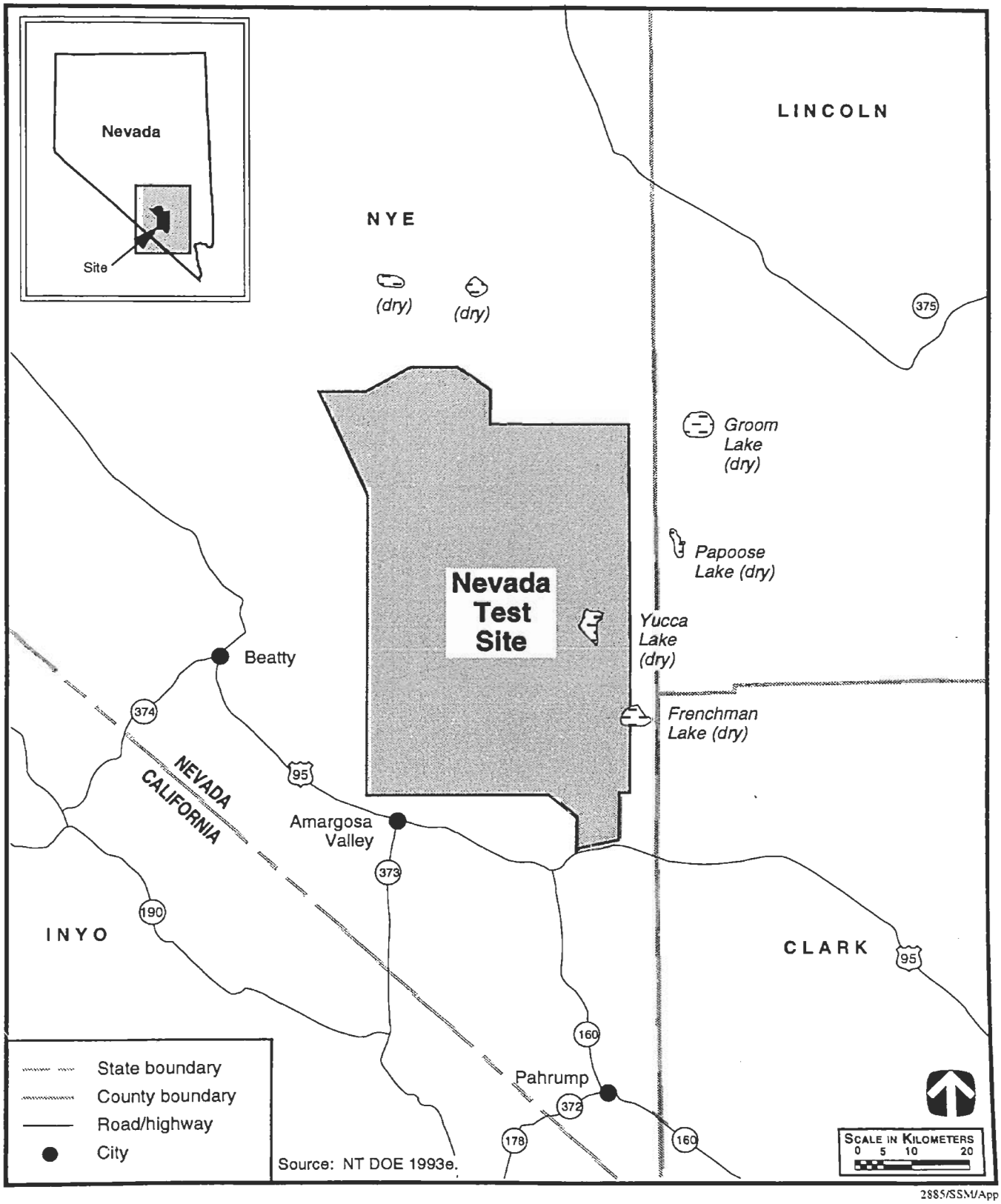


FIGURE A.1.8–1.—*Nevada Test Site, Nevada, and Region.*

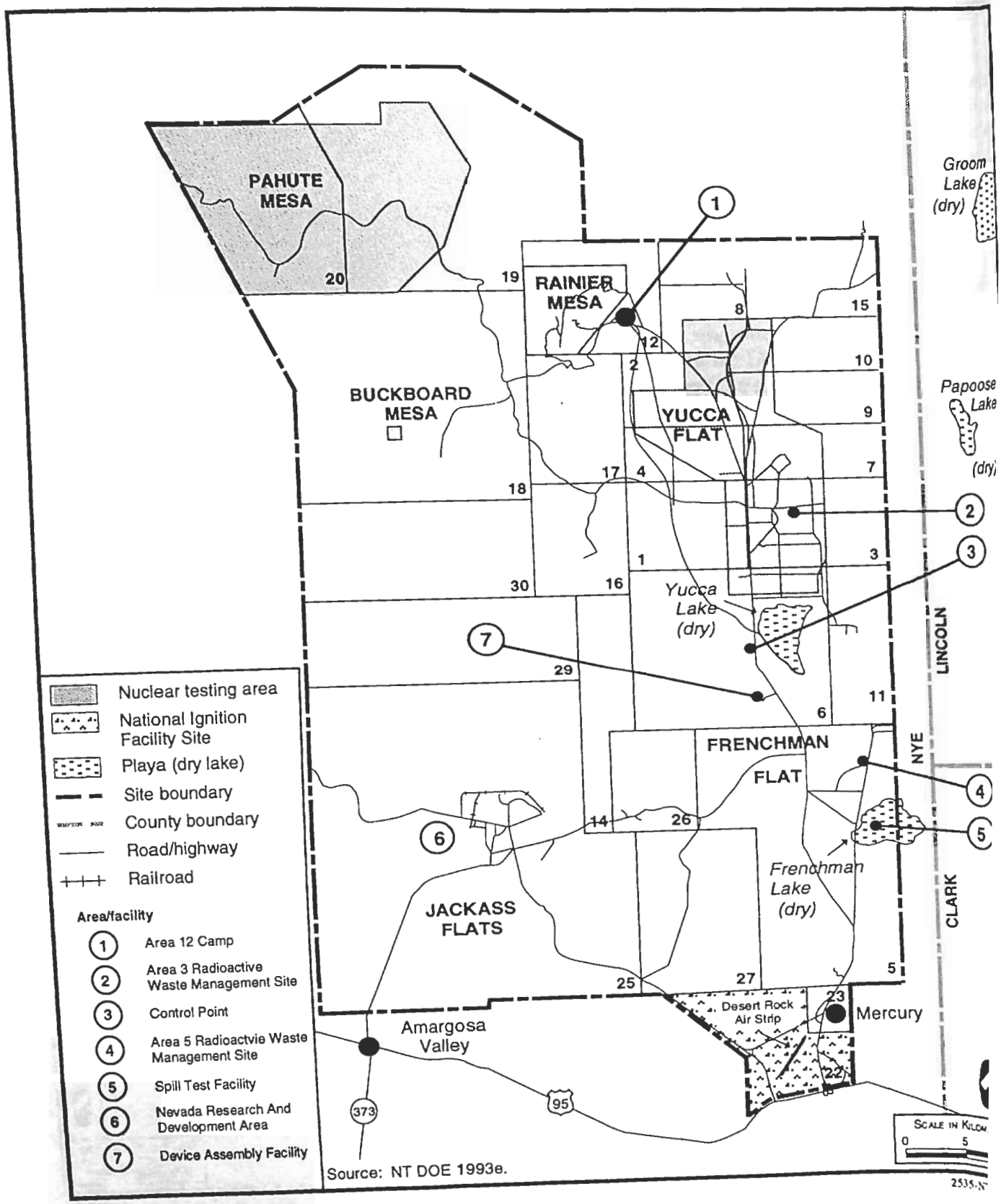


FIGURE A.1.8–2.—*Principal Facilities and Testing Areas at Nevada Test Site.*

assets at NTS include about 1,200 buildings with 8,000 units of installed equipment, approximately 640 km (400 mi) of primary and secondary surfaced roads, and 480 km (300 mi) of unsurfaced roads.

The NTS water system consists of many wells, pumps, booster pumps, and many sumps, reservoirs, chlorinator water softeners, and 160 km (100 mi) of supply and distribution lines. This water system has an average weekly production of 40 million liters (L) (10.5 million gallons [gal]). Total well capacity is 21,670 liters per minute [lpm] (5,752 gallons per minute [gpm]). Twelve wells supply water for domestic use on NTS.

Electrical power to NTS is supplied by Nevada Power Company and Valley Electric Association transmission lines. Both transmission lines are rated at 138 kV. The Nevada Power Company line is approximately 96 km (60 mi) long and ties into the NTS transmission system near Mercury. The Valley Electric Association line is more than 160 km (100 mi) long. It runs from the Amargosa Valley substation and ties into the NTS transmission system at Jackass Flats substation. This system (the Nevada Power Company/Valley Electric Association transmission lines) is capable of providing 45 megawatt electric (MWe) based on a single contingency failure. NTS has over 1,120 km (700 mi) of overhead and underground transmission and distribution power lines. NTS also uses a small amount of liquid fuel. Table 4.9.2.2–1 shows the annual usage of resources. Current missions at NTS are shown in table 3.2.9–1. The major DP facilities located at NTS are shown in table A.1.8–1.

In December 1950, President Truman established the Nevada Proving Grounds (forerunner to NTS) as the Nation's on-continent nuclear weapons testing area. The first nuclear test at NTS occurred on January 27, 1951. At that time, the nuclear weapons program was administered by the Atomic Energy Commission (AEC), Albuquerque Operations Office. AEC employees were sent to the Nevada Proving Grounds for the duration of a test series and then returned to Albuquerque. As tests became more frequent during the 1960s, the AEC created the Las Vegas-based Nevada Operations Office, which officially opened on March 6, 1962, and has since administered NTS operations. Approximately 40 percent of the total Nevada Operations Office budget for fiscal year 1992 was for DP activities.

Desert Rock Air Strip is located southwest of Mercury. The airstrip has, in busier times, provided scheduled air service by DOE aircraft between NTS and LLNL, LANL, and SNL, for access by researchers and testing personnel. Currently, it is used only for high priority shipments.

Construction of the only major new facility, the Device Assembly Facility, is essentially complete; however, existing facilities are modified on an as-needed basis. Drilled holes for groundwater monitoring are always in the process of being selected, designed, and developed. A waste management facility is being considered for handling transuranic (TRU) waste from DOE facilities; this and the Solar Power Production Facility are the only major non-DP facilities anticipated for NTS.

TABLE A.1.8–1.—*Major Defense Program Facilities at Nevada Test Site*

Facility	Functions
Device Assembly Facility (DAF)	Assembly of nuclear test devices
Lyner Facility	Underground subcritical testing, dynamic experiments with special nuclear materials
Area 27, Critical Assembly Facilities	Assembly bays, storage magazines, and radiography buildings maintained for use as an alternative to the Device Assembly Facility
Able Site	Maintained for resumption of testing pending Device Assembly Facility operations, and for operations involving HE and special nuclear materials
Baker Site	HE operations and staging
Big Explosive Experimental Facility (BEEF)	Conventional HE testing

Source: NT DOE 1996c; NTS 1996a:1.

vities. Historically, most of the e has been related to DP activ- stablished in December 1950, ncipal testing location for the ons program. As of September ted States had conducted 28 of which were on NTS and underground. Underground ed at the Area 6 Control Point ntains the technical, managerial, ure to control the site.

en noted, since the *U.S. Nuclear n Act* went into effect in early nclear tests have been conducted tes. On the day immediately October 4, 1993 nuclear test, issued a directive to DOE to n indefinitely a state of readiness tion of U.S. testing. Other aspects rdship activities at NTS include id permitted HE tests, subcritical nts, and hydrodynamic tests.

bly Facility is the only new major tivities at NTS. This 9,290 m^2 ity was authorized in 1984. It is just south of Control Point One. It centralize most functions and facil- ing device assembly area. The / Facility will enable LLNL and multiple operations with HE and imultaneously. All aspects of the handled in this one facility because ssing areas include assembly cells, high bays, radiographic facilities, naterials laboratories, HE staging, materials staging, shipping and and associated administrative and n addition, the facility will provide verall security and permit easier it for the workers during hazardous ecial nuclear materials will not be r machined at this facility; only the l material storage/staging functions ed here.

erations Office has been delegated the ole in maintaining the capability to tain kinds of national emergencies. It e leadership when a Federal Radiolog- ng and Assessment Center is estab- lished. Additionally, a team of highly trained DOE and contractor radiological specialists known as the Nuclear Emergency Search Team trains, tests equipment for search and detection, and stores equipment for rapid deployment under the auspices of the Nevada Operations Office. It can be mobilized in case of accidents involving radioactive material or a terrorist threat involving nuclear weapons.

Other Department of Energy Activities. Although th principal activity at NTS is testing nuclear device DOE is also involved in a number of other activitie These activities include liquefied gaseous fuels sp testing, solar technology demonstration, radioacti and mixed waste disposal, and the Yucca Mount characterization programs. NTS has also been des nated a DOE National Environmental Research Par

The Spill Test Facility in Area 5 was completed 1986. It is operated on a fee basis for commer users as a basic research tool for studying dynamics of accidental releases of hazard materials and to evaluate the effectiveness of var foams and fire retardants in accidents involv chemicals and hazardous materials. Test fac personnel discharge a measured volume of hazar test fluid at a controlled rate onto a surface spec prepared to meet the test requirements and re close-in and downwind meteorological data gaseous concentration levels.

NTS is a proposed site for a program sponsor DOE for a Solar Enterprise Zone. As part o program, a 100 MWe solar power plant is pro to be built at NTS. The power from this plant v support Government needs in the area, an remainder would be sold to the commercial This size plant can be supported with the ex transmission lines at NTS. There is also poter expand the solar power capability at NTS to a imately 500 MWe in the future; howeve expansion would require substantial infrastr upgrades including new transmission lines. T 100 MWe plant is expected to be in place and ating by the 2005 No Action timeframe.

NTS also operates radioactive waste disposa ties. The Radioactive Waste Manageme located in Area 5, accepts LLW materials th generated in the Nation's DP activities. Thi (92-acre) facility consists of trenches and burying LLW and aboveground storage f

waste awaiting transfer to the Waste Isolation Pilot Plant (WIPP). Also located at the Area 5 Radioactive Waste Management Site are Greater Confinement Disposal Units, which consist of 3 m (10 ft) in diameter partially cased shafts that are 37 m (120 ft) deep. These units were used for disposing of waste not suited for shallow land burial because of high exposure and potential for migration into biopathways. Management in charge of Greater Confinement Disposal is considering using different disposal configurations (other than boreholes). Nonradioactive hazardous wastes are also accumulated at the Area 5 Radioactive Waste Management Site awaiting shipment to offsite treatment and disposal facilities. In Area 3, the Radioactive Waste Management Site uses surface subsidence craters (that were formed by underground nuclear tests) for the emplacing and burying of LLW in bulk form (such as debris collected from atmospheric nuclear test locations).

The Yucca Mountain Site is located along the western boundary of NTS. It is being considered by DOE for the disposal of spent power-reactor fuel and vitrified HLW, the latter resulting principally from DP activities. The Yucca Mountain Site Characterization Project staff reports directly to DOE's Office of Civilian Radioactive Waste Management; however, because it has elements based on NTS, the Nevada Operations Office provides some administrative and operational support services to the project.

Recently, NTS has been designated as a DOE National Environmental Research Park with a purpose of consolidating previous ecological reports, filling in a significant gap in the existing DOE research park network, and providing a unique opportunity for research in the arid desert environment. This not only enables NTS scientists to link into the existing ParkNet computerized data system, but also makes the extensive accumulation of environmental research collected over the history of NTS available to students and scientists throughout the world. NTS's location in the transition zone between the Southern and Northern Basin and Range Ecological Regions, and its inclusion of vast undisturbed areas of mountain ridges, closed basins, and diverse ecological communities makes it particularly valuable.

Non-Department of Energy Activities. The most significant NTS activity involving non-DOE organizations has been the Defense Nuclear Agency's Nuclear Testing Facility. Congressional legislation (the *Hatfield Amendment*), however, limited nuclear testing to those tests that support the safety and reliability of the U.S. nuclear stockpile. This may preclude further Defense Nuclear Agency nuclear tests, which are done to support research into nuclear weapons effects.

Defense Nuclear Agency nuclear tests occurred in horizontal tunnels mined beneath Rainier Mesa. The nuclear devices for these tests were designed, built, funded, controlled, and executed by the Office of Defense Programs. The Defense Nuclear Agency's nuclear testing provided the database and design information for both nuclear effects and survivability. Nuclear weapons-effects were studied for all U.S. tactical and strategic weapons systems that were required to operate in a nuclear warfare environment. These tests played a major role in maintaining high confidence in the nuclear stockpile and nuclear-capable weapons systems. The weapons-effects tests were conducted to study a number of nuclear effects including x-ray, gamma-ray, neutron, stress (thermal, electrical, and mechanical), electromagnetic pulse, airblast, ground and water shock propagation, and temperature effects. These tests assessed both weapons effects and the survivability of military systems in a nuclear environment.

Area 25 has been used for a variety of purposes, including U.S. Army ballistic research using depleted uranium and transporter testing for the proposed mobile MX missile. Various military exercises and training activities are also conducted in and around Area 25.

The Desert Research Institute, EPA, the University of Utah, and the Nevada Operations Office operate the Community Radiation Monitoring Program. This program provides the community surrounding NTS with an increased understanding of its activities and the natural radiation environment.

Other activities have been and will likely continue to be carried out for other Federal departments and agencies. Representatives from EPA, the U.S. Geological Survey, and the National Oceanic and Atmospheric Administration are onsite to assist and monitor conditions.

Environmental Regulatory Setting. The State of Nevada has regulatory authority for air, water, solid

waste, and hazardous waste. A Memorandum of Understanding between DOE and the state covers required notifications whenever there might be radiological releases from NTS. DOE and the state also signed an Agreement in Principle in October 1990 to provide DOE funding to Nevada for oversight of environmental activities at NTS, including environmental restoration activities. The Agreement in Principle provides the understanding between and commitment of both parties regarding DOE's provision of technical and financial support to the state in return for environmental oversight and monitoring.

The remainder of this section summarizes the status of NTS compliance with the major environmental regulations.

National Environmental Policy Act. The site-wide EIS for NTS and offsite locations in the state of Nevada examines existing and potential impacts to the environment that have resulted, or could result, from current and future DOE operations in southern Nevada. The EIS analyzes the impacts from DOE programs at the following sites: NTS, the Tonopah Test Range, portions of the Nellis Air Force Range Complex, the Central Nevada Test Area, and the Project Shoal Area. These programs include ongoing activities for the stewardship of the national nuclear weapons stockpile, management of radioactive waste, and environmental restoration. Also examined in the EIS are newer programs, such as the proposed Solar Enterprise Zone sites at NTS, Dry Lake Valley, Eldorado Valley, and Coyote Spring Valley.

Comprehensive Environmental Response, Compensation, and Liability Act. NTS has soils contaminated by plutonium and other radioactive materials as a result of past testing operations. EPA is in the process of ranking NTS according to the Hazard Ranking System based on the preliminary assessment/site investigation reports prepared in 1988. Concurrently, the state is negotiating a Federal Facility Agreement with DOE for environmental restoration, including restoration mixed waste. Nevada has taken this action pursuant to the state's corrective actions regulations to negotiate a formal cleanup agreement with DOE rather than waiting for EPA to list NTS on the NPL under provisions of CERCLA. If an agreement between the state and DOE is signed, it is unlikely that EPA will further pursue ranking NTS.

Emergency Planning and Community Righ Know Act. The State of Nevada combine reporting requirements of Section 312, Tier II R with the information requirements for the Ne State Fire Marshall Division Uniform Fire Materials Report. NTS reports to the State of Ne information on 28 chemicals in 36 areas which above the reporting threshold. In addition, the of Nevada *Chemical Catastrophe Prevention A* 1992 requires the registration of highly hazar substances above predetermined thresholds.

Resource Conservation and Recovery Act. D received a permit for the Explosive Ordna Disposal Unit and the Hazardous Waste Storage in May 1995. RCRA Corrective Action is inclu in the permit for these two facilities. The Envi mental Restoration Program under Corrective Ac activities will be the major contributor to the gen tion of mixed waste.

As provided in the June 23, 1992, Settlem Agreement for Mixed TRU waste, NTS is allowe continue to operate the Area 5 Radioactive Wa Management Site TRU Waste Storage Pad in acc dance with 40 CFR, Part 265, Subpart I. T agreement also requires that DOE submit a rep documenting why the current inventory of mix TRU cannot be removed until WIPP becomes ope tional and on the progress DOE is making to cer the stored TRU waste to WIPP Waste Accepta Criteria. In January 1994, a Mutual Cons agreement was established between DOE and state allowing DOE to use the available stor capacity on the TRU Waste Storage Pad for storage of onsite generated low-level mixed w that cannot be disposed because the waste does meet the RCRA standards of treatment for l disposal. The Mutual Consent Agreement amended in June 1995 to allow for all mixed w generated by DOE within the State of Nevada t stored at the TRU waste storage pad.

NTS is registered as a hazardous waste generato no. NV3890090001) and is routinely inspected b Nevada Division of Environmental Protec There were no Findings of Alleged Violation id fied from the RCRA Annual Compliance Evalu conducted at NTS near the end of 1993 because is conducting RCRA operations in compliance had corrected previous RCRA findings; unres

findings have been incorporated as part of the enforceable agreements between DOE and the state.

The Federal Facility Compliance Act of 1992. This act is an amendment to RCRA. DOE published the Interim Mixed Waste Inventory Report in April 1993, annual updates, and periodic updates since, describing its inventory of mixed wastes and treatment capabilities. A Site Treatment Plan was issued in October 1995 and its provisions will be incorporated into the Consent Order being negotiated between the state and DOE.

Clean Air Act. There are no criteria pollutant or prevention of significant deterioration monitoring requirements for NTS operations. However, NTS does comply with other requirements established by the CAA, State of Nevada air quality controls, radionuclide monitoring, and air permit compliance. As of December 31, 1993, NTS operations are in full compliance with standards of 40 CFR 61, Subpart H (National Emissions Standards for Emissions of Radionuclides Other than Radon from DOE Facilities). NTS air quality permits limit particulate emissions to 20 percent opacity. Seven permitted equipment/processes, such as weapons event stemming operations, have been identified as routinely exceeding the 20 percent opacity requirement. NTS requested an independent study of fugitive dust emissions from permitted equipment and from surface disturbance operations to identify means of improving NTS air quality emissions. Recommendations were either instituted or equivalent changes were made to improve overall NTS air quality emissions. Chlorofluorocarbon recycling equipment is in place at all NTS service and maintenance centers. Freon is recovered and reused, eliminating ozone-depleting substance emissions into the atmosphere almost completely.

Clean Water Act. Wastewater discharges at NTS facilities are not regulated under NPDES permits because all such discharges are to onsite sewage lagoons. Discharges to these lagoons are permitted under the *Nevada Water Pollution Control Act.* Monitoring and reporting requirements are typically included under local permit requirements. Wastewater monitoring at NTS is required for sampling wastewater influents to sewage lagoons and containment ponds. The sewage lagoons are in compliance and are routinely inspected by State of Nevada personnel. DOE has requested a formal determination by the state concerning the regulatory situation of NTS reference stormwater requirements based on both Standard Industrial Code usage and whether waters of the United States exist on NTS. The Nevada Division of Environmental Protection must determine if requirements under Federal stormwater discharge regulations are relevant to NTS. This determination is still pending.

Safe Drinking Water Act. Compliance with this act primarily addresses the quality of potable water supplies at NTS as determined through the sampling and monitoring requirements for drinking water systems. The State of Nevada has enacted and enforces SDWA regulations and also regulates daily system operations. DOE developed an operations and maintenance plan to address standard operating procedures for water system operations at NTS. The State of Nevada classifies NTS water system as requiring a Grade II Water System Operator Certification. NTS provides such a certified operator. To meet requirements under the state health regulations, potable water distribution systems at NTS are monitored for residual chlorine content, coliform bacteria, VOCs, inorganic compounds, and other water quality standards. Drinking water systems are in compliance with standards.

Toxic Substances Control Act. State of Nevada regulations that implement this act require submission of an annual report which describes the quantity and status of PCBs and PCB-contaminated equipments as well as shipments of PCBs and PCB-contaminated items from NTS to an EPA-approved disposal facility. NTS is managing PCBs, asbestos, and chemicals in compliance with applicable regulations.

Federal Insecticide, Fungicide, and Rodenticide Act. Pesticide usage includes insecticides, herbicides, and rodenticides. Records are maintained on all pesticides used for at least 3 years. All applicators are provided the opportunity to receive state-sponsored training materials.

North Las Vegas Facility. This is a 32-ha (80-acre) site within the Las Vegas urban area. The site is positioned along Losee Road which runs parallel to and is a short distance west of Interstate 15. It is a quarter mi (0.4 km) north of Carey Avenue and 1 mi (1.6 km) south of Cheyenne Avenue in the city of North Las Vegas. It is bordered on the north, south, and east by general industrial zoning. The western border is

adjacent to Commerce Street, which separates the site from fully developed single-family residential zoned property. Electrical power is supplied to the site by the Nevada Power Company, and natural gas is supplied by Southwest Gas Corporation. The city of North Las Vegas supplies the water and sanitary sewer services. The site consists of office and warehouse buildings with one large high bay and a tower as well as a large paved area for trailers. Mechanical and technical support functions associated with the underground test program were performed at this site. LLNL, LANL, and SNL used the North Las Vegas Facility (NLVF) to prepare, assemble, and test the instrumentation rack and canister assembly prior to deployment to NTS for testing operations.

NLVF, although considered an adj
independently comply with many
ronmental requirements just as
operations at NLVF have envir
ments similar to the requirements
acre) sites in the city of North La

A.2 Stockpile Stewardship Descriptions

The stockpile stewardship proje
PEIS are the proposed NIF, the
the proposed Atlas Facility. De
analyses of these alternatives ar
dixes I, J, and K, respectively.

A.3 Stockpile Management Project Descriptions

A.3.1 Weapons Assembly/Disassembly

Weapons A/D is a key element of the DOE stockpile management responsibility. This function provides the capability to: dismantle retired weapons; assemble HE, nuclear components, and nonnuclear components into nuclear weapons; repair and modify weapons; perform weapons surveillance; and store strategic reserves of nuclear components (pits and secondaries).

Weapons A/D consists of five main functions:

- Weapon assembly
- Weapon disassembly
- Joint test assembly and post-mortem
- Test bed A/D
- Storage of plutonium and HEU strategic reserves

The functions, as described in the following subsections, would vary between weapon programs. The plant must have the capability to vary production operations and quality assurance tests to meet the special needs of each program.

Weapons contain special nuclear material. Operations involving special nuclear material must be conducted within a critical assembly area. Weapons, joint test assemblies, and test beds contain HE and explosive detonators; therefore, operations involving these must be conducted in facilities designed for explosives operations.

Weapon Assembly. Weapon assembly is performed to produce a new weapon, to rebuild a weapon that has been disassembled for surveillance, or for modification or replacement of components. The assembly steps for a rebuild are the same as for a new build, except that the starting point varies, depending on the extent of disassembly.

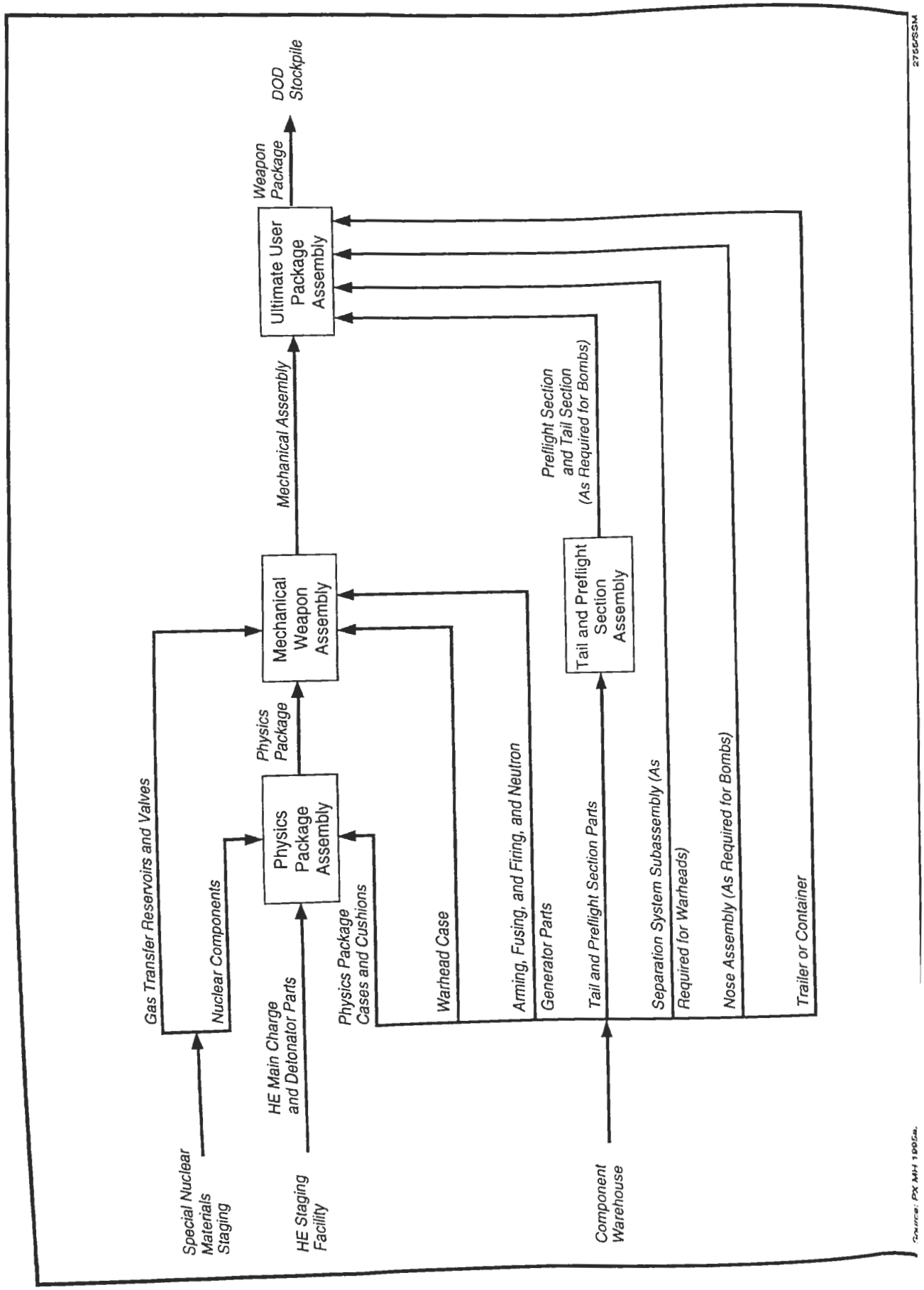
Weapon assembly requires approximately 2,000 steps to combine hundreds of parts and subassemblies to form a weapon. The process is labor-intensive and includes many verification and quality control steps. Prior to the start of the assembly process, several bays would be configured with special tooling required for the specific weapons operations. As the assembly progresses, partially assembled weapons may be moved in series from bay to bay. At several points during assembly, the weapon would be moved from assembly bays to special purpose bays. These special purpose bays would be permanently configured with nonprogram specific equipment for performing verification or inspection operations, such as radiography inspection, leak testing, and mass properties determination.

Complete weapon assembly would be accomplished in three stages: physics package (also known as nuclear explosive package) assembly, mechanical weapon assembly, and ultimate user package assembly. The weapon assembly function is shown in figure A.3.1–1, and each stage is described below. Weapon parts would be unpackaged, cleaned, verified and, in some cases, tested prior to assembly.

Physics package assembly entails bonding or mating the main charge subassemblies to a nuclear pit and then enclosing this subassembly in a case along with other components. Prior to assembly, gamma spectrometry would be used to verify the authenticity of the nuclear components. The pit would also be leak-tested and weighed. After the physics package is cased, tests would be performed to ensure electrical continuity, and a radiographic inspection would be conducted to ensure that the internal subassemblies are correctly aligned.

When the main charge is made from conventional HE, the physics package assembly must be conducted in a specialized structure called an assembly cell. An assembly cell is designed to minimize the release of radioactive material in the event that the conventional HE detonates. After the physics package is cased, the potential for detonation is greatly reduced, and the physics package may be moved to an assembly bay. The physics package for a weapon using an insensitive HE main charge can be assembled in a bay. The completed physics package then continues to mechanical weapon assembly.

Mechanical weapon assembly entails placing the physics package in a warhead case and installing


Special Nuclear Materials Staging
HE Staging Facility
Component Warehouse
Gas Transfer Reservoirs and Valves
Nuclear Components
HE Main Charge and Detonator Parts
Physics Package Assembly
Physics Package
Physics Package Cases and Cushions
Warhead Case
Arming, Fusing, and Firing, and Neutron Generator Parts
Mechanical Weapon Assembly
Mechanical Assembly
Tail and Preflight Section Parts
Tail and Preflight Section Assembly
Preflight Section and Tail Section (As Required for Bombs)
Separation System Subassembly (As Required for Warheads)
Nose Assembly (As Required for Bombs)
Trailer or Container
Ultimate User Package Assembly
Weapon Package
DOD Stockpile
2766SSM

components for the arming, fuzing, and firing systems; the neutron generator; and the gas transfer system. At prescribed points during the assembly process, electrical testing and gas transfer system pressure testing would be conducted to verify proper installation. The completed mechanical package would be leak-tested, backfilled with a specified gas atmosphere, inspected with radiography, and subjected to mass properties testing. Leak-testing would ensure that the weapon case is properly sealed. Radiographic inspection would be used for verification of the weapon system. Mass properties testing measures the center of gravity and moments and products of inertia to ensure proper flying characteristics. The final stage of the mechanical weapon assembly is the user package assembly.

Ultimate user package assembly involves installing some additional components and packaging the weapon for shipment. This operation varies, depending on whether the mechanical assembly is used in a bomb or a warhead. For bombs, components such as the tail, nose, and/or preflight sections would be added. Tail and preflight sections would be preassembled prior to installation. The completed bomb would be loaded onto a trailer (roadable) for shipment. Warheads may have a separation subassembly installed and the completed warheads would be loaded into containers for shipment. The ultimate user assembly would be moved to the weapon staging area for shipment to DOD via safe secure trailer.

Weapon Disassembly. Weapon disassembly is performed to dismantle, modify, or evaluate a weapon. The operations conducted for each type of disassembly are similar, but the extent of the disassembly and procedures vary.

Dismantlement Disassembly. The weapon would be disassembled down to subassemblies and components that are suitable to be shipped to the originators, that facilitate recertification of usable parts, or that facilitate sanitization and demilitarization of unusable parts.

Modification (Retrofit) Disassembly. A weapon requiring modification would be disassembled to the extent necessary to gain access to the components requiring replacement. The disassembly procedures are intended to maximize reuse of parts.

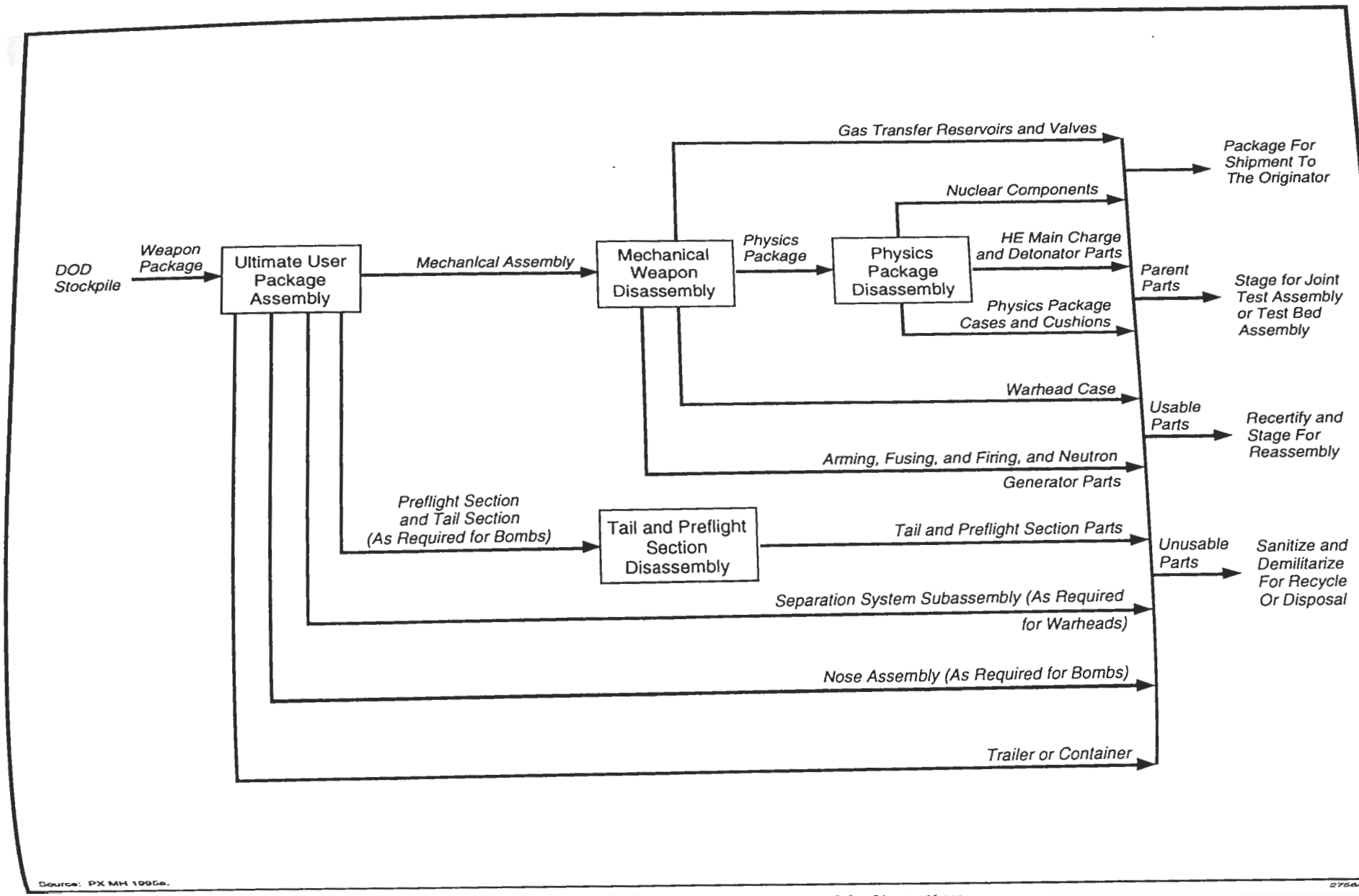
Stockpile Evaluation Disassembly. The evaluations and tests required would be defined by the design laboratories. The extent of disassembly depends on which components require testing. Procedures include additional testing, and typically call for removing components in connected groups to facilitate further testing in test beds or joint test assemblies.

The weapon disassembly process is similar to the reverse of the assembly process and would be accomplished in three stages: ultimate user package disassembly, mechanical weapon disassembly, and physics package disassembly. Many of the facilities used for various disassembly and testing operations are the same facilities used for weapon assembly. The weapon disassembly function is shown in figure A.3.1–2, and each stage is described below.

Ultimate user package disassembly begins by performing a series of verification steps to ensure that the weapon is in a safe condition and that internal components are intact. The steps include tritium monitoring, electrical safing system test, gamma spectrometry safeguards verification, and a radiographic safing system verification. Bombs would be removed from trailers, and mechanical assemblies would be separated from the tail and nose sections. Warheads would be removed from ultimate user containers and then mechanical assemblies would be separated, as required, from separation subassemblies.

Mechanical weapon disassembly also begins with a series of tests. These tests include an internal atmosphere test check, a radiographic inspection, and a tritium pressure leak test. Evaluation of disassemblies may also require vacuum chamber leak test and mass property testing. The mechanical weapon disassembly entails removing the components for arming, fuzing, and firing systems; neutron generators; the gas transfer system; and the outer weapon case. The remaining physics package is further disassembled. The physics package may require a radiographic inspection for an evaluation disassembly.

Physics package disassembly would be accomplished by opening the case, removing the HE/pit subassembly and other components, and then separating the HE main charge from the nuclear pit. As



Source: PX MH 1995a.

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described for weapon assembly, the physics package disassembly must be performed in a cell if the main charge is conventional HE.

The balance of the weapon disassembly function involves processing various weapons parts. These parts may be disassembled further on site or left intact. Parts may be recertified and staged for reassembly, shipped to the originating site for evaluation or disposition, or processed as residual material in the waste management process. Selected components may be assembled in a test bed or the bulk of the components may be used in a joint test assembly.

Joint Test Assembly and Post Mortem. As part of the ongoing stockpile evaluation program, weapons are randomly selected from the stockpile or new production inventory for conversion to joint test assemblies. A joint test assembly is a nuclear explosive-like assembly (mock weapon) that will be test flown by DOD. A joint test assembly generally contains most of the original weapon parts, except for the nuclear components and main charge subassemblies. A joint test assembly also contains telemetry components to monitor joint test assembly performance during flight, mock materials to simulate the size and weight of missing components, and witness plates to verify that energetic actuators performed as expected.

A process flow diagram of the joint test assembly support function is shown in figure A.3.1–3. Assembly of a joint test assembly is similar to weapon assembly, but some components are different. The physics package equivalent for a joint test assembly is called joint test subassembly. A high degree of quality control is required due to the high cost of the complex test.

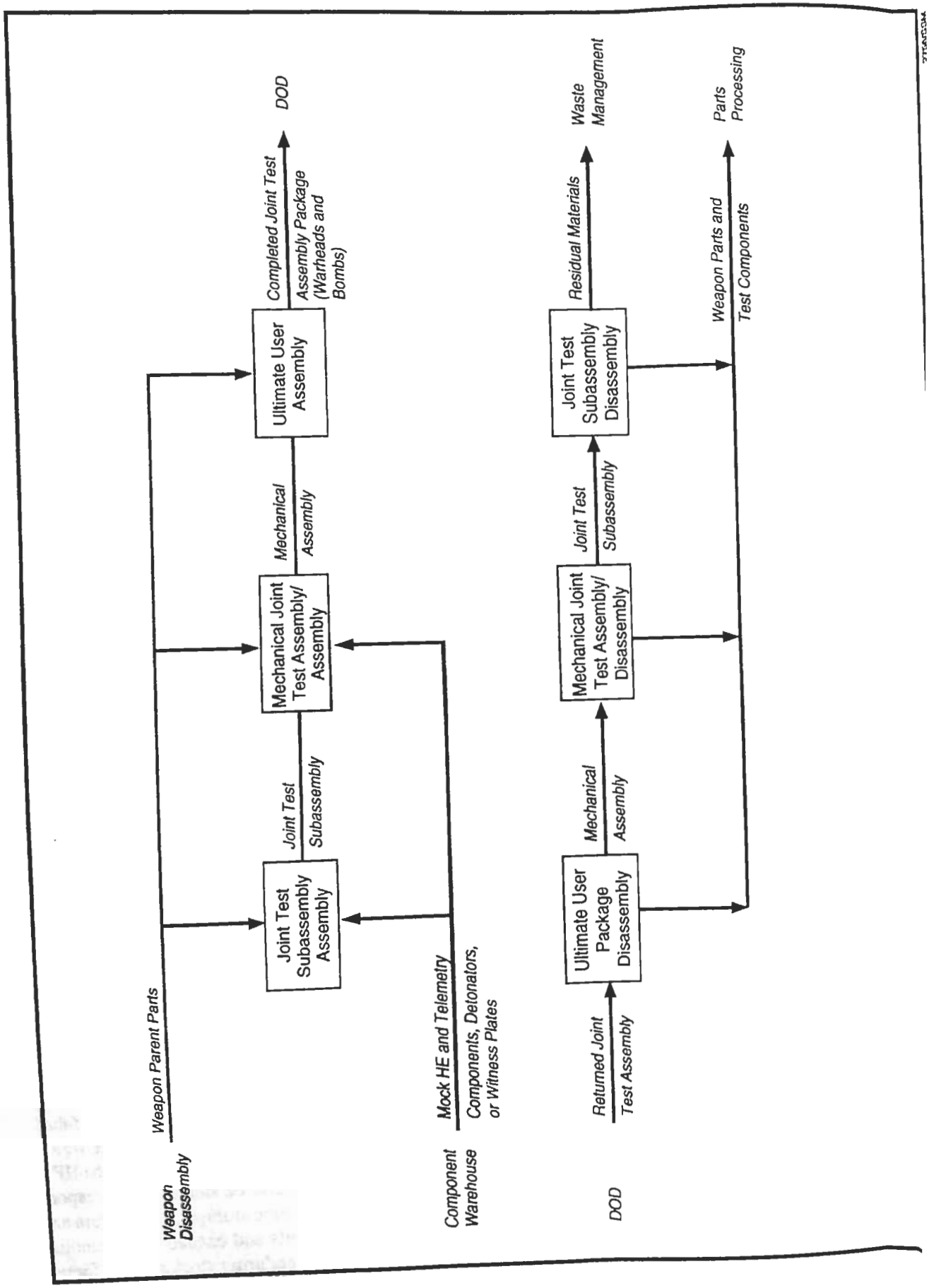
After the flight test, joint test assemblies for bomb programs are generally recovered and returned for post-mortem disassembly and evaluation. Joint test assemblies for warhead programs are recovered if possible and returned for evaluation. The parts obtained from disassembly are processed for disposal. The procedures for joint test assembly are similar to those for a weapon disassembly, except that additional measures are taken to contain residues produced by the energetic actuators. The parts obtained from disassembly may be recertified and staged for reassembly, shipped to the originating site for evaluation or disposition, or processed in the waste management facility.

Joint test A/D operations, as well as the special evaluations such as radiography gamma spectrometry and leak-testing required for joint test assemblies, are performed in the same bays and special purpose bays used to conduct weapon assembly and disassembly operations.

Test Bed for Assembly and Disassembly. A test bed is an apparatus used for bench testing weapon systems, subsystems, and components. It is composed of parts removed from a weapon in evaluation disassembly and an explosive box. The explosive box contains the blast and fragments from the small explosive charges which detonate as the weapons systems are tested. The weapon parts are generally from the arming, fuzing, and firing systems and include antennas, radio frequency lines, radar, programmers, fire sets, detonator cables, and permissive action links. Prior to testing, some test beds are exposed to temperature extremes in environmental conditioning ovens. The testing is conducted at fully instrumentated test stations that can simulate deployment temperatures.

The test bed support function is shown in figure A.3.1–4 and is described below. Test bed assembly entails constructing the explosive box and parent part assembly and mounting these items on the test fixture. The explosive box is manufactured by enclosing explosive or electro-explosive components in an explosive barricade containing a fill material to damp the detonations. The explosive box may also contain a fiber optic sensing system to monitor the actuation timing. The parent parts assembly is composed of the removed weapon parts. The explosive box may also contain parent parts.

Optional Storage of Plutonium and Highly Enriched Uranium Strategic Reserves. Storage of the plutonium strategic reserve could occur at the weapons A/D Facility (as shown in figure A.3.1–5). If Y-12 is selected as the site for the secondary fabrication mission, HEU strategic reserve storage would remain at ORR. If Y-12 is not selected, then the HEU strategic reserve could also be stored at the weapons A/D Facility. The strategic storage of plutonium and HEU provides cased pits and canned subassemblies for replacement in the enduring stockpile and for use


Weapon Disassembly
Weapon Parent Parts
Component Warehouse
Mock HE and Telemetry
Components, Detonators, or Witness Plates
Joint Test Subassembly Assembly
Joint Test Subassembly
Mechanical Joint Test Assembly/ Assembly
Mechanical Assembly
Ultimate User Assembly
Completed Joint Test Assembly Package (Warheads and Bombs)
DOD
DOD
Returned Joint Test Assembly
Ultimate User Package Disassembly
Mechanical Assembly
Mechanical Joint Test Assembly/ Disassembly
Joint Test Subassembly
Joint Test Subassembly Disassembly
Residual Materials
Waste Management
Weapon Parts and Test Components
Parts Processing

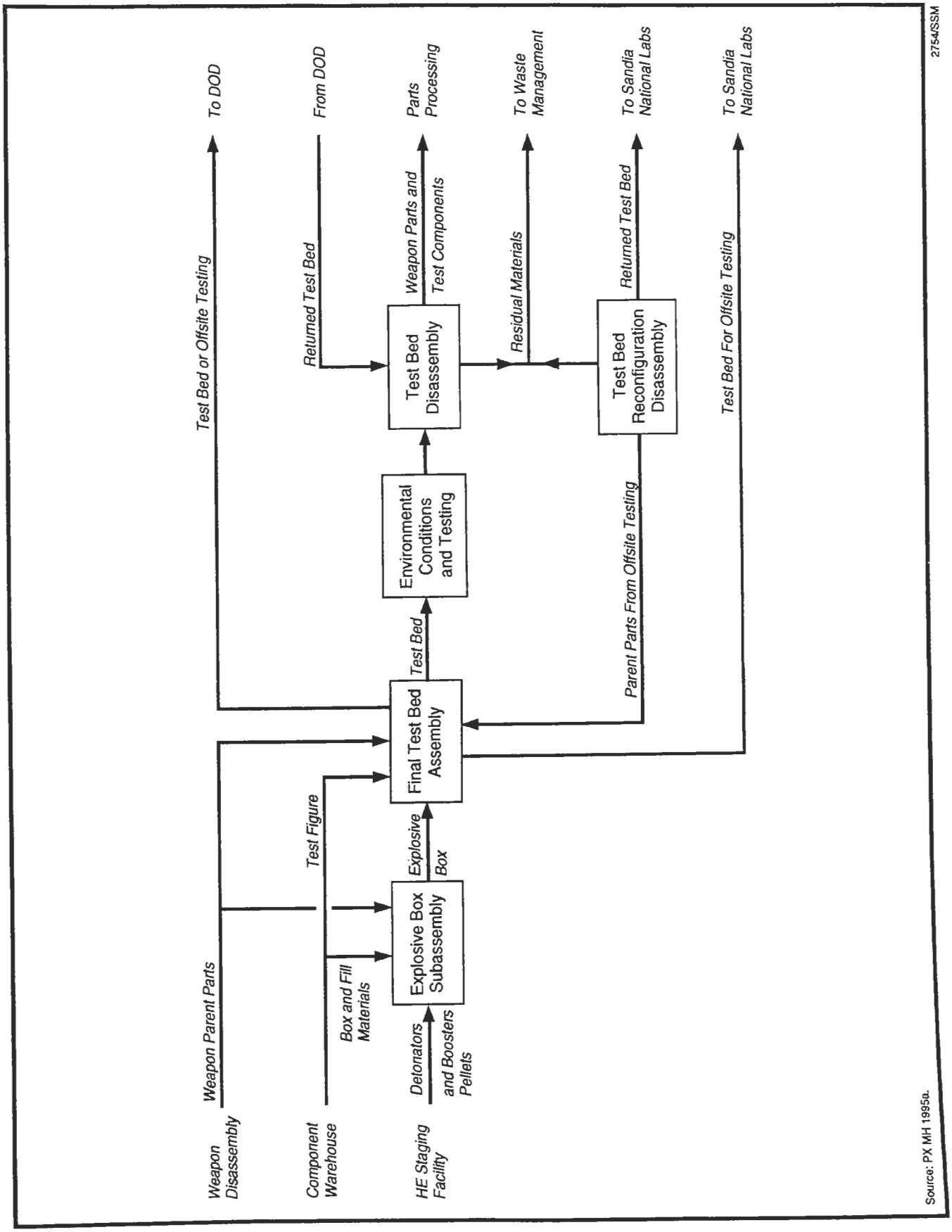
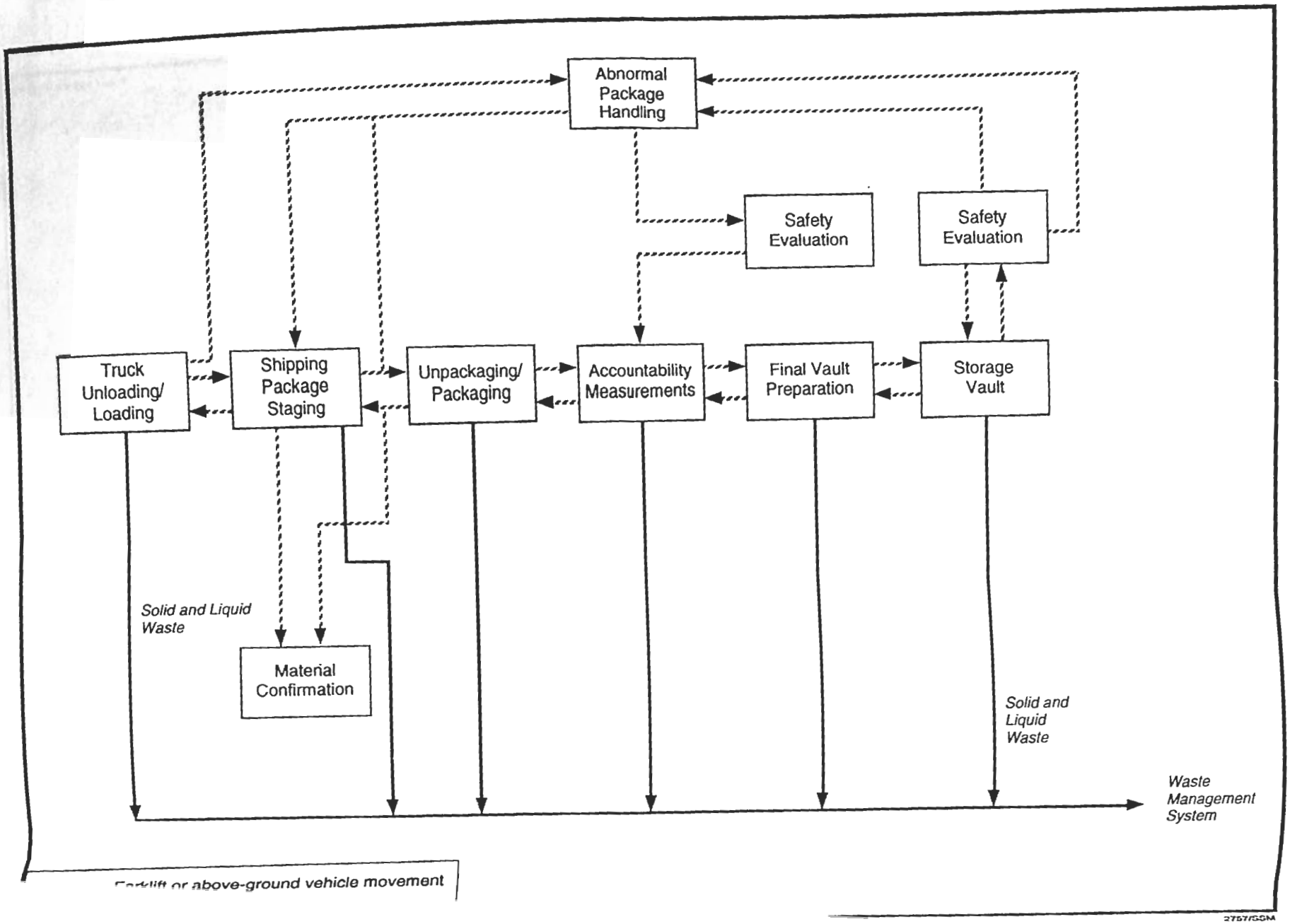


FIGURE A.3.1–4.—*Test Bed Support Function.*


Abnormal Package Handling
Safety Evaluation
Safety Evaluation
Truck Unloading/ Loading
Shipping Package Staging
Unpackaging/ Packaging
Accountability Measurements
Final Vault Preparation
Storage Vault
Solid and Liquid Waste
Material Confirmation
Solid and Liquid Waste
Waste Management System
Forklift or above-ground vehicle movement
2757/SSM

as feedstock for nuclear fabrication. The quantities associated with the storage are identified in classified documents. If the responsibility for strategic storage is transferred to the Office of Materials Disposition, then consolidated storage could be at one of five sites being considered in the Storage and Disposition PEIS.

The weapons A/D process constructs a weapon from approximately 200 parts and subassemblies. Assembly feeds include main charge subassemblies from the HE fabrication plant, special nuclear material components, weapon parts and subassemblies, electrical components, and hardware. A joint test assembly has approximately the same number of parts as a weapon. Feeds include most of the weapon parts removed from an evaluation weapon disassembly, telemetry components, mock HE and special nuclear material components, and witness plates. Test bed feeds include selected weapon parts removed from an evaluation disassembly, small explosive parts, the explosive box, the test fixture, electrical components, and hardware. The feeds for disassembly operations include nuclear weapons, joint test assemblies, and test beds.

A.3.1.1 *Downsize at Pantex Plant*

Pantex is the existing A/D site for the U.S. nuclear weapons stockpile. To efficiently meet the workload established by DOE for fiscal year 2004 and beyond, operations would be consolidated into the facilities that exist at Pantex. No new facility construction is required to accomplish the consolidation of the A/D mission. Changes would only be required to allow the relocation and modification of some functions into the newer facilities and the upgrade of some infrastructure systems.

The five main functions for A/D operations discussed in section A.3.1 would be downsized and consolidated at Pantex. The site plans for the consolidated A/D operations at Pantex are shown in figures A.3.1.1–1 and A.3.1.1–2. The drawings depict the arrangement of plant buildings and site support areas for Pantex. Four types of security access areas exist at Pantex: material access area, protected area, limited area, and property protection area. Operations involving special nuclear material must be performed within a material access area. The material access area and some facilities supporting material access area operations are located in the protected area. The protected area is secured with a double fence and intruder detection systems. The protected area and operations involving classified materials and information are contained within a limited area. The property protection area surrounds the limited area and includes a buffer zone. Weapons A/D operations are performed within the material access area within Zone 12.

The downsizing and consolidation of A/D operations would enable Pantex to utilize existing structures. Consideration has been given to optimizing operations, as well as maximizing the use of facilities, in the downsizing analysis. No new construction would be required at Pantex to accomplish the reduced weapons A/D mission. Pantex has 59 A/D bays, of which only 31 bays are required to meet the A/D workload. Therefore, functions that reside in older facilities (not economically or technically feasible to upgrade) would be relocated to modern, heavy-type construction facilities.

All facilities at Pantex were built in compliance with design codes and standards in effect at the time of design and construction. At the time of any major modification, facilities were upgraded commensurate with codes and standards at the time of the modification. Where applicable, facilities were built to specific regional design criteria.

Structures containing explosives are generally constructed with steel-reinforced concrete and are designed to mitigate the effects of an accidental explosion. The resulting facility design typically consists of a number of separate operating bays that could vent to an unoccupied area should a detonation occur. Structures that do not require concrete construction due to the presence of special nuclear materials or HE are generally constructed of steel, although portions of these buildings may be concrete. Most facilities include support areas for offices; break rooms; rest rooms; electrical heating, ventilation, and air conditioning equipment; maintenance; and in-process staging of materials, components, tooling, and supplies. Many production and laboratory facilities also include vacuum systems.

Key facilities required to meet the mission of the A/D downsized and consolidated operations are listed in

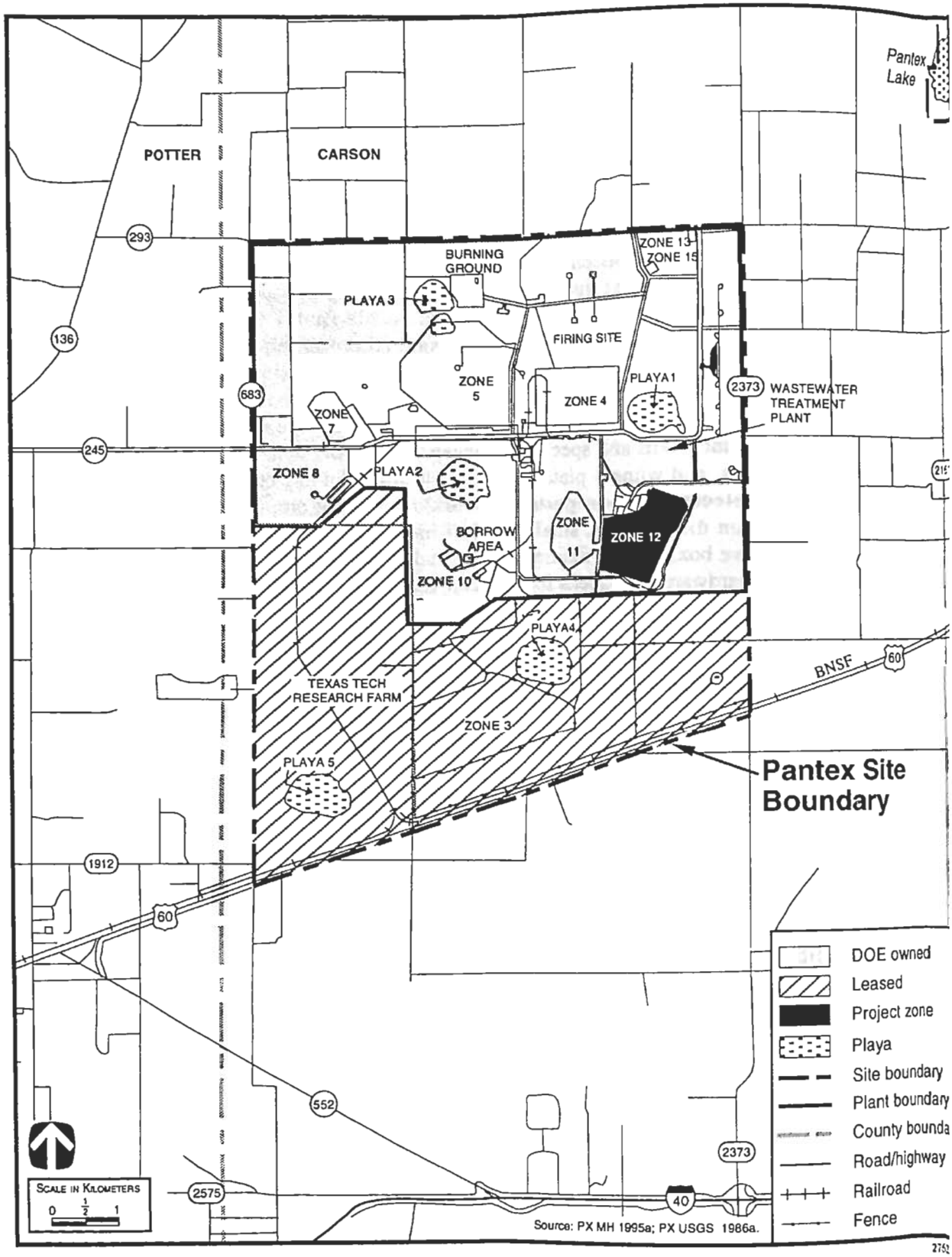


FIGURE A.3.1.1–1.—*Weapons Assembly and Disassembly Zones at Pantex Plant.*

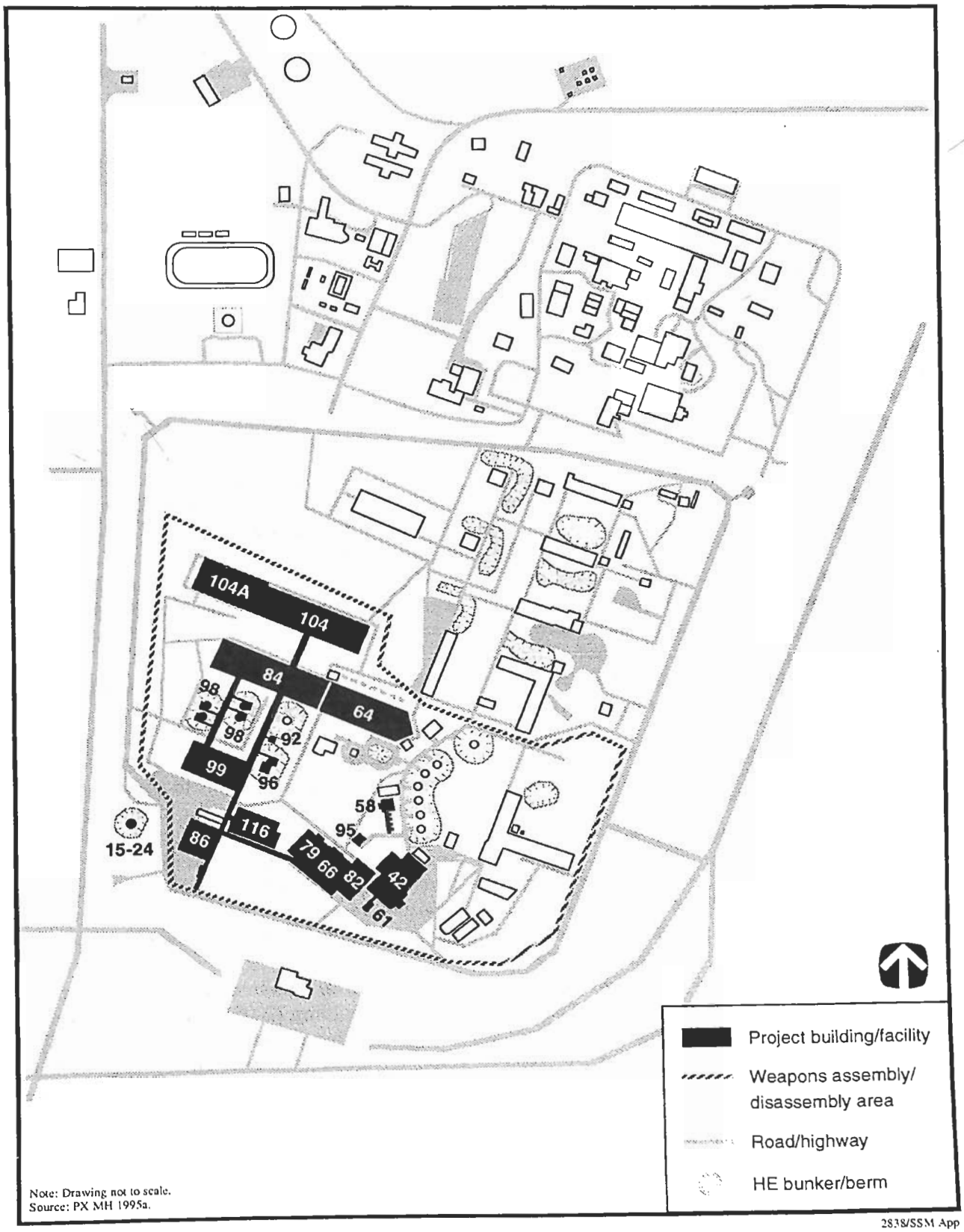


FIGURE A.3.1.1–2.—*Weapons Assembly/Disassembly Site Plan at Pantex Plant (Zone 12).*

table A.3.1.1–1. A brief description of key facilities follows.

Assembly Bays. Assembly bays are used to manually assemble or disassemble nuclear weapons. Weapon assembly requires approximately 2,000 steps to combine hundreds of parts and subassemblies to form a weapon. The process is labor-intensive and includes many verification and quality control steps. Prior to assembly, several bays are configured with special tooling required for assembly of a specific weapon. As assembly progresses, partially assembled weapons move in series from bay to bay. The physics package for a weapons program using a conventional HE main charge must be assembled in an assembly cell. The weapon disassembly process is conceptually the reverse of the assembly process, although tooling used and testing required will vary. High fidelity joint test assemblies (those containing explosives and/or special nuclear material) are also assembled and disassembled in bays.

Pantex has several A/D bay facilities; however, only 31 bays in Buildings 12-084, 12-099, and 12-104 are required. Each bay includes an area to perform assembly operations, staging areas for tooling and weapon parts, and a mechanical room for heating, ventilation, and air conditioning equipment and controls.

Assembly Cells. Assembly cells are designed to support the manual assembly or disassembly of a physics package for weapon programs using a conventional HE main charge. Physics package assembly involves mating explosive and nuclear components and sealing these components in a metal case. Assembly cells are designed to mitigate the release of radioactive material in the event that conventional HE detonates. After the physics package is cased, the potential for a detonation is greatly reduced and the physics package may be moved to an assembly bay. Assembly in a cell is not required for a physics package using an insensitive HE main charge.

Each cell includes an area to perform assembly operations; staging areas for special nuclear material, tooling, and weapon parts; and a mechanical room for heating, ventilation, and air conditioning equipment and controls. Prior to the start of the assembly process, an assembly cell is configured with special tooling to facilitate the assembly or d assembly of a specific weapon program. Pantex h 13 assembly cells; however, only 4 of the assem cells (three in Building 12-098 and the 12-96 cell) required.

Special Purpose Bays. Special purpose bays similar to assembly bays, but special purpose b are permanently configured with special equipm to perform general testing or assembly operatio As with assembly bays, special purpose bays grouped and share some common support areas. functions performed in these bays are describec the following sections.

Test Bed Assembly/Disassembly. Test beds training units are assembled and disassembled in of Building 12-086. Training units are nucle explosive-like assemblies that are used for train Pantex and DOE personnel to build, repair, maint and handle nuclear weapons. The facility contai number of universal assembly bays which are con ured with program-specific tooling. No modif tions are required in this facility to support test functions.

Nondestructive Evaluation. Linear accelera computed tomography, and x-ray radiography performed in part of Building 12-104A. Th functions are used to inspect components, ass blies, and complete weapons to confirm proper figuration. Ultrasonic testing detects voids in material used to bond close fitting parts. Acou emissions testing detects flaws in material. Ra metric inspection identifies the types of enca radioactive materials. No modifications are requ in this facility to support the downsizing of Pante

Environmental/Physical Properties Testing. portion of Building 12-084 is used to perform no structive testing of weapon components. Wea components are subjected to mechanical and the shock to simulate deployment conditions. Mech cal conditioning tests include vibration, hos shock, mini-air gun shock, and steady-state accel tion shock. Environmental chambers are use simulate temperature extremes and thermal sh conditions. Equipment would be relocated f other areas of the plant into Building 12-08 support this function.

TABLE A.3.1.1–1.—*Pantex Plant Downsized and Consolidated Weapons Assembly/Disassembly Facility Data* [Page 1 of 2]

Building Number	Description	Type of Construction	Gross Area (m^2)	Footprint Area (m^2)	Security Access Area	Number of Levels	Special Material
12-008	Commercially procured weapon material	Steel	56	56	Limited area	1	None
12-042	Tester and tooling storage	Steel	4,404	4,404	Material access area	1	None
12-042 A/B/C/ D/F	Weapons evaluation testing	Steel/concrete	2,044	2,044	Material access area	1	HE
12-053/E	Metrology lab	Concrete	474	474	Material access area	1	None
12-058	HE component staging	Concrete	242	242	Material access area	1	HE
12-059/E	Commercially procured weapon material/chemical lab	Steel	771	771	Limited area	1	None
12-061	Component warehouse	Steel	2,230	2,230	Material access area	1	None
12-079	Component warehouse	Steel	2,666	2,666	Material access area	1	None
12-082	Special nuclear material container refurbishment/component tech acceptance	Concrete	632	632	Material access area	1	None
12-084	17 assembly/disassembly bays, 1 pit laser bay, 1 nondestructive evaluation environmental bay, metallurgical evaluation	Concrete	10,675	10,675	Material access area	1	HE/special nuclear material
12-086	Test bed assembly, electronic testing, gas lab, metrology lab	Concrete	4,479	3,627	Material access area	2	HE
12-092	Component packaging	Steel	88	88	Material access area	1	HE
12-095	Explosives Class C staging	Concrete	244	244	Material access area	1	HE
12-096	1 assembly/disassembly cell	Concrete	731	731	Material access area	1	HE/special nuclear material
12-098/E	3 assembly/disassembly bays, passive action link code activated process	Concrete	3,192	3,192	Material access area	1	HE/special nuclear material

TABLE A-3.1.1-1—Pantex Plant Demolished and Consolidated Weapons Assembly/Disassembly Facility Data [Page 2 of 2]

Building Number	Description	Type of Construction	Gross Area (m^2)	Footprint Area (m^2)	Security Access Area	Number of Levels	Special Material
12-099	3 assembly/disassembly bays, weapon staging	Concrete	5,639	5,639	Material access area	1	HE/special nuclear material
12-104	11 assembly/disassembly bays	Concrete	7,917	7,917	Material access area	1	HE/special nuclear material
12-104A	Paint, mass properties, separations testing, accelerated aging, 2 staging bays, 1 vacuum chamber and purge backfill bay, 1 x-ray bay, 1 computed tomography, 1 linear accelerator bay	Concrete	6,503	6,503	Material access area	1	HE/special nuclear material
12-104P	Generator buildings	Steel	NA	NA	Material access area	1	None
12-116	Special nuclear material component staging, AT-400A processing	Concrete	4,274	4,274	Material access area	1	Special nuclear material
12-117	Special nuclear material loading dock	Steel	576	576	Material access area	1	None
Total			63,233				

Note: NA = not applicable.
Source: PX MH 1995a.

Leak Detection and Backfill. Leak rate tests are performed in one bay of Building 12-104A with vacuum chambers (or fixtures) on all outgoing nuclear weapons and on units returned from the field to ensure that the weapon case is properly sealed and correct internal atmosphere is maintained. Backfill involves filling the inside of the weapon case with a specific gas. This operation is performed following completion of a leak rate test and an evacuation step. No modifications are required in this facility to support the downsizing of Pantex.

Mass Properties Determination. Mass properties are critical for ensuring proper flight characteristics of a weapon. Products of inertia and lateral center of gravity are determined with remotely operated dynamic balancing machines. Center of gravity and moments of inertia are determined with a special machine. Modifications are required in one bay of Building 12-104A to allow existing equipment to be relocated to support this function.

Painting and Body Work. Weapons and weapon components, joint test assemblies, containers, and trailers are painted, repainted, or touched-up in a portion of Building 12-104A. Old paint is removed with sandblasting or chemical stripping. Minor dents in nonweapon components are straightened. No modifications are required to support this function.

Accelerated Aging. Accelerated environmental aging is conducted to simulate the aging process on newly produced weapons and weapon components in a portion of Building 12-104A. For these tests, weapons or materials are placed in an environmental chamber and subjected to thermal cycling above and below ambient temperatures for an extended period, typically from 1 to 2 years. Gas samples are taken from the weapon and analyzed in the gas laboratory. The accelerated aging chamber consumes a significant amount of electrical power. After aging, weapons are disassembled and evaluated. No facility modifications are required to support this function.

Separations Systems Testing. Selected reentry body separation subassemblies are tested in a portion of Building 12-104A to provide data for evaluating release assembly hardware and associated installation procedures and for measuring service-related deterioration of the release assembly system. Facility modifications are required to allow the existing equipment to be relocated and operate in this area.

Special Nuclear Material Container Refurbishment. Containers used to ship radioactive components are reverified annually in a portion of Building 12-082. The structural integrity of containers is verified through leak tests, visual inspection, and maintenance. No modifications are required in Building 12-082 to support this function.

Pit Laser Sampling. A gas sample is taken for selected weapon system pits to determine the internal atmosphere type, percentage, and pressure. Pit laser sampling occurs in a bay in Building 12-084. No modifications are required in this facility.

AT-400A Processing. Pits are robotically packaged into the AT-400A, a hermetically sealed container. The AT-400A container meets requirements for long-term storage and shipping of pit items. This activity would occur in a portion of Building 12-116. The AT-400A robotics processing equipment and required modifications to Building 12-116 to accept this activity are included in the Pantex No Action alternative.

Component Packaging. Packaging of selected reaccepted weapon components occurs in Building 12-092, a special access area. No modifications are required in this facility.

Component Technical Acceptance. Components are reaccepted for assembly using a variety of inspection/verification techniques. This activity will occur in Building 12-082. No modifications are required to support this function.

Weapons Evaluation Testing Laboratory. Weapon system, subsystem, and component tests are conducted in Building 12-042 A/B/C/D/F by SNL personnel. Numerous fully instrumentated test stations are provided for heating, cooling, and test firing the tests beds. A cryogenic carbon dioxide system is used for cooling these units during testing. Environmental conditioning ovens and centrifuges are also provided for testing components under deployment conditions. No modifications are required in this facility.

Metrology Laboratory. Buildings 12-086 and 12-053 are used for metrology functions within the material access area. Instruments and testers for weapon assembly operations are calibrated here. Some areas within these facilities require tight heating, ventilation, and air conditioning temperature control to ±0.3 °C (±0.5 °F). Modifications are required in Building 12-086 to allow existing equipment to be relocated.

Gas Laboratory. Gas analyses are performed in Building 12-086 and are used to evaluate samples from accelerated aging tests and production operations. Information from these analyses provides data related to the internal atmosphere of weapons and effects of weapon material aging by measuring outgassing products. The three basic techniques used are gas fractionation, gas chromatography, and mass spectrometry. Facility modifications are required for this function which would relocate existing equipment into Building 12-086.

Weapon Material Testing Laboratory. A laboratory for testing and accepting commercially procured weapon material is located in Buildings 12-008 and 12-059. No modifications are required for these facilities.

Tooling/Tester Storage. Precision tools, instruments, testers, and special equipment for A/D operations are stored in Building 12-042. Generic assembly bays and cells are configured with program-specific tooling at the beginning of a production run. Tooling storage would contain tools for assembly, disassembly, and evaluation operations for all the weapon programs in the enduring stockpile. This function would be relocated from another facility into Building 12-042.

Weapon Staging. A portion of Building 12-099 is used for staging nuclear weapons awaiting transportation to and from DOD facilities. No facility modifications are required to accommodate weapons staging.

Special Nuclear Material Component Staging. The special nuclear material staging facilities, Buildings 12-116 and a loading area 12-117, are designed to ship, receive, and stage special nuclear material. The facilities include segregated staging bays and inspection equipment.

Inert Component/Container Warehouses. Buildings 12-058, 12-061, 12-079, and 12-095 are used for storing, repackaging, and distributing inert weapon components, materials, and containers for Pantex HE components to support A/D are staged in Building 12-058. Weapons and special nuclear material are staged in other buildings. These facilities include storage racks, a loading dock, and areas designed for packaging and unpackaging and shipping and receiving. No modifications are required in these facilities.

Strategic Reserves Storage. The plutonium and HE strategic reserves would be stored in Area 12.

Requirements for Construction and Operation
Downsizing and consolidating A/D operations at Pantex would require approximately 0.2 ha (0.4 acres) of land for construction material laydown. There would be no associated disturbed land area involved with downsizing of operations at Pantex. Material and resources consumed during the 3-year construction period are listed in table A.3.1.1–2. The principal source of air emissions during construction would be fugitive dust from site preparation and construction activities and exhaust from construction equipment and vehicles. Annual emissions during a peak construction year are presented in table A.3.1.1–3.

The number of workers required during each construction year is presented in table A.3.1.1–4.

The weapon A/D process requires the following utilities: electricity, plant air for operating pneumatic tools and hoists, instrument air for radiation monitors, steam for heating test beds in environmental conditioning ovens, cryogenic carbon dioxide for cooling test bed test stations, and water for operating vacuum pumps. Utilities consumed during surge operation can be found in table A.3.1.1–5.

Chemicals consumed during operation primarily include water treatment chemicals, materials for facility equipment and vehicle maintenance, and bottled gases. Annual estimated chemical use during surge operations is listed in table A.3.1.1–6.

Emissions. Emissions result from plant boiler operation and cleaning operations that use solvents. Releases would be limited to what is possible, using best available control technology. Emissions for the

TABLE A.3.1.1–2.—*Pantex Plant Downsizing and Consolidating Weapons Assembly/Disassembly Construction Materials/Resources*

Material/Resource	Total Consumption	Peak Demand[a]
Electricity	609 MWh	4 MWe
Water (L)	1,400,000	
Concrete (m^3)	840	
Steel (t)	15	
Liquid fuel and lube oil (L)	28,800	
Industrial gases (m^3)[b]	600	

[a] Peak demand for electricity is the maximum rate. Peak demand for water is the average daily consumption during a 1-year period with construction activity.

[b] Cubic meters measured at standard temperature and pressure.

Source: PX MH 1995a.

TABLE A.3.1.1–3.—*Pantex Plant Downsizing and Consolidating Weapons Assembly/Disassembly Construction Emissions*

Pollutant	Quantity (t)
Sulfur dioxide	0.04
Nitrogen oxides	0.46
Volatile organic compounds	0.23
Carbon monoxide	1.26
Particulate matter	0.19
Total suspended particulates	0.46

Source: PX MH 1995a.

downsizing and consolidating alternative A/D surge operations are shown in table A.3.1.1–7.

Radiological release for A/D operations are limited to uranium isotopes and tritium. These releases are the result of assembly and disassembly operations, as well as waste operations. Extremely small releases of plutonium (near background) are possible.

Weapons Assembly Transportation. As illustrated in figure A.3.1.1–3, the two major types of radiological hazardous materials that would be transported to Pantex include special nuclear material components

TABLE A.3.1.1–4.—*Pantex Plant Downsizing and Consolidating Weapons Assembly/Disassembly Construction Workers*

Employees	Year 1	Year 2	Year 3	Total
Craftworkers				
Carpenter	1	7	2	10
Concrete mason	1	5	1	7
Electrician	0	6	5	11
Iron worker	1	8	1	10
Laborer	2	6	2	10
Millwright	0	2	1	3
Operator	0	3	1	4
Sheet metal worker	0	7	2	9
Pipe fitter	0	5	3	8
Sprinkler fitter	0	5	1	6
Teamster	1	3	1	5
Other craftworkers	0	4	3	7
Total Craftworkers	6	61	23	90
Construction management and support staff	1	6	2	9
Total Employment	7	67	25	99

Source: PX MH 1995a.

TABLE A.3.1.1–5.—*Pantex Plant Downsizing and Consolidating Weapons Assembly/Disassembly Surge Operation Annual Utility Requirements*

Utility	Consumption	Peak Demand
Electricity	43,000 MWh	10 MWe
Liquid fuel (L)	740,000	
Natural gas (m^3)	7,150,000	
Water (L)	196,000,000	

Source: PX MH 1995a.

and HE components. Special nuclear material would be shipped in safe secure trailers. Upon arrival at the site, a safe secure trailer would proceed directly to the weapon staging facility. Movement of explosive components would be performed by trucks and battery-powered vehicles specifically designed for this purpose. The quantity of HE (conventional and insensitive) transported onsite by these trucks would be strictly limited.

TABLE A.3.1.1–6.—*Pantex Plant Downsizing and Consolidating Weapons Assembly/Disassembly Surge Operation Annual Chemical Requirements*

Chemical	Quantity (kg)
Acetone	227
Argon	8,165
Carbon dioxide	49,896
Circlene FG 20	635
Clepox 143	635
Degreaser	680
Desiccants	454
Dispersant	290
Dry air	771
Eco-Star	2,858
Ethyl acetate	544
Ethyl alcohol	227
Fixer and replenisher	1,497
Glass beads	408
Glass cleaner	1,452
Helium	1,769
Heptane	318
Hydraulic/lubricating oil	29,030
Inorganic proprietary	2,722
Joint compound	1,179
Micro liquid lab cleaner	363
Mild steel metal	5,897
Molecular sieve	1,043
Neutrasorb acid neutralizer	272
Nitrogen	3,629
Paint	16,330
Planisol-M concentrate	363
Polyalkylene and ethylene glycol	240
Potassium hydroxide	408
Siliconized ammonium phosphate base	590
Sodium chloride	34,020
Solksorb solvent absorbent	1,769
Specialty gas mixtures	1,542
Stainless steel metal	2,268
Sulfuric acid	363
TISAB with CDTA	862
Water treatment chemicals[a]	11,340

[a] Chlorine, sodium sulfite, sodium sulfate, sulfuric acid, poly electroly, and phosphoric acid.

Source: PX MH 1995a.

TABLE A.3.1.1–7.—*Pantex Plant Downsizing and Consolidating Weapons Assembly/Disassembly Surge Operation Annual Emissions*

Pollutant	Quantity (t)
Ammonia	<0.001
Carbon monoxide	5.4
1,2-Dichloroethane	<0.001
Nitrogen oxides	21.3
Particulate matter	0.8
Sulfur dioxide	<0.001
1,1,1-Trichloroethane	0.44
2,2,4-Trimethyl-1,3-Pentane diolbutyrate	<0.001
Volatile organic compounds	11.3

Source: PX MH 1995a; PX 1996e:1.

All major weapon assembly work would be performed in assembly bays and cells. Special nuclear material would be transferred from staging areas by battery-powered vehicles travelling on ramps. After final assembly and inspection, weapons would be transferred to the weapon staging facility on ramps. Weapons would then be shipped offsite by safe secure trailer.

Small quantities of low-level, mixed, and hazardous wastes generated during assembly of nuclear weapons would be collected, packaged, and transported by electric car to local accumulation sites and then by truck to a low-level staging area near the waste management facility. The wastes would be transferred by truck for offsite disposal.

Weapons Disassembly Transportation. As illustrated in figure A.3.1.1–4, returning weapons would be delivered in safe secure trailers. After a security inspection, weapons would be unloaded and temporarily stored in the same weapons staging area used for outgoing assembled weapons. Individual weapons would be transported to an assembly bay or cell by a battery-powered vehicle travelling on a ramp. After disassembly, the various special nuclear material components would be transported by battery-powered vehicles to staging areas for subsequent shipment offsite. HE components would be transported by electric vehicle to the HE staging area for subsequent transportation to the HE fabrication plant. Waste would be collected, transported, and disposed of in a manner similar to that described for weapons assembly.

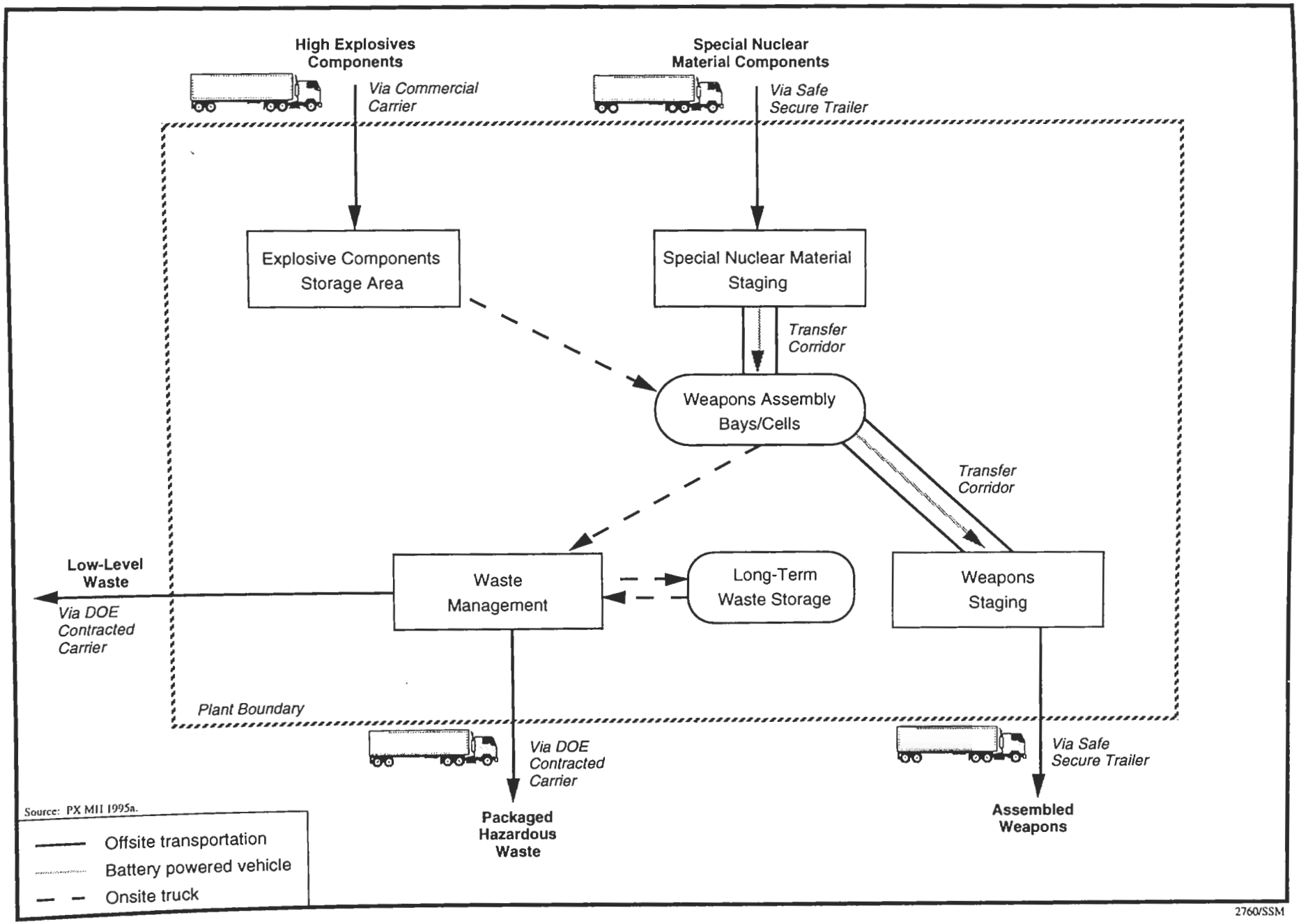
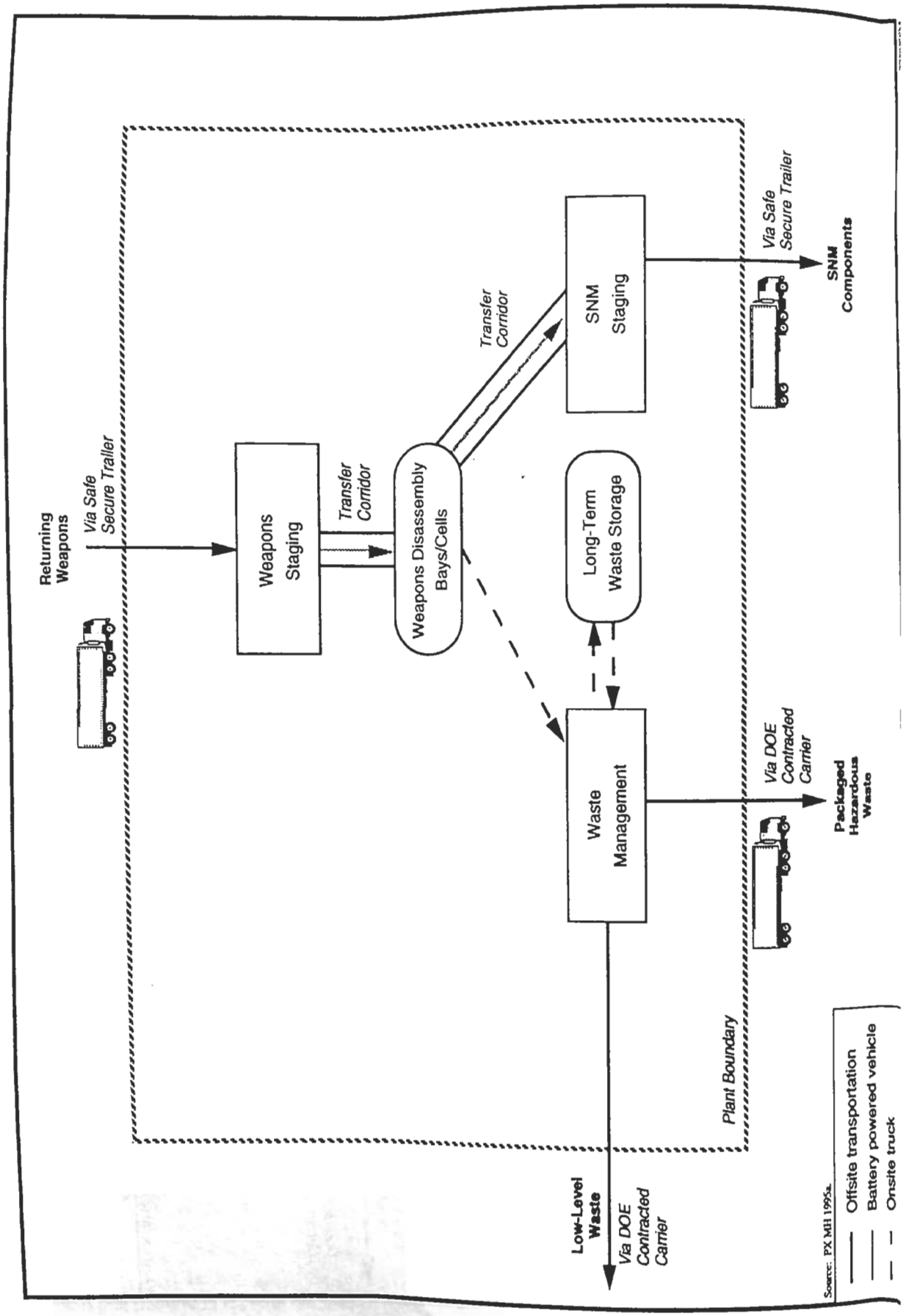


FIGURE A.3.1.1–3.—*Weapons Assembly Transportation Diagram at Pantex Plant.*


Returning Weapons
Via Safe Secure Trailer
Weapons Staging
Transfer Corridor
Weapons Disassembly Bays/Cells
Transfer Corridor
SNM Staging
Via Safe Secure Trailer
SNM Components
Long-Term Waste Storage
Waste Management
Via DOE Contracted Carrier
Packaged Hazardous Waste
Low-Level Waste
Via DOE Contracted Carrier
Plant Boundary
Offsite transportation
Battery powered vehicle
Onsite truck
Source: PX MH 1995a.

Waste Management. Pantex waste management is described in detail in appendix section H.2.4. The liquid and solid nonhazardous wastes generated over a 3-year period would include concrete and steel construction waste materials and sanitary wastewater. The steel construction waste would be recycled as scrap material before completing construction. The remaining nonhazardous wastes generated during construction would be disposed of as part of the construction project by the contractor. Wastewater would be used for soil compaction and dust control or processed through the Pantex sanitary wastewater system. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes generated during construction would consist of such materials as waste adhesives, oils, cleaning fluids, solvents, and coatings. Hazardous waste would be packaged in Department of Transportation (DOT)-approved containers and shipped offsite to commercial RCRA-permitted treatment, storage, and disposal facilities. No radioactive waste would be generated during construction.

The project design incorporates waste minimization and pollution prevention. Segregation of activities that generate radioactive and hazardous wastes would be employed, where possible, to avoid the generation of mixed wastes. Where applicable, treatment to separate radioactive and nonradioactive components would be performed to reduce the volume of mixed wastes and provide for cost-effective disposal or recycle. To facilitate waste minimization, where possible, nonhazardous materials would be substituted for those materials that contribute to the generation of hazardous or mixed waste. Production processes would be configured, with minimization of waste production given high priority. Material from the waste streams would be treated to facilitate disposal as nonhazardous wastes, where possible. Future D&D considerations have also been incorporated into the design.

Table A.3.1.1–8 presents the estimated annual waste volumes from the A/D and pit recertification, requalification, and reuse facility during construction and surge operations. Solid and liquid waste streams are routed to the waste management system. Figure A.3.1.1–5 depicts the waste management system. Solid wastes would be characterized and segregated into LLW, hazardous, and mixed wastes, then treated to a form suitable for disposal or storage within the facility. Liquid wastes would be treated onsite to

TABLE A.3.1.1–8.—*Pantex Plant Weapons Assembly/Disassembly Waste Volumes*

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations (m^3)	Annual Volume Effluent from Surge Operations (m^3)
Low-Level			
Liquid	None	0.06	None
Solid	None	21[a]	10[b]
Mixed Low-Level			
Liquid	None	0.06	0.06
Solid	None	Minimal	Minimal
Hazardous			
Liquid	None	2	2
Solid	0.25	0.05	0.05
Nonhazardous (Sanitary)			
Liquid	315	141,000	141,000
Solid	5[c]	340	170[d]
Nonhazardous (Other)			
Liquid	Included in sanitary	Included in sanitary	Included in sanitary
Solid	Included in sanitary	Included in sanitary	Included in sanitary

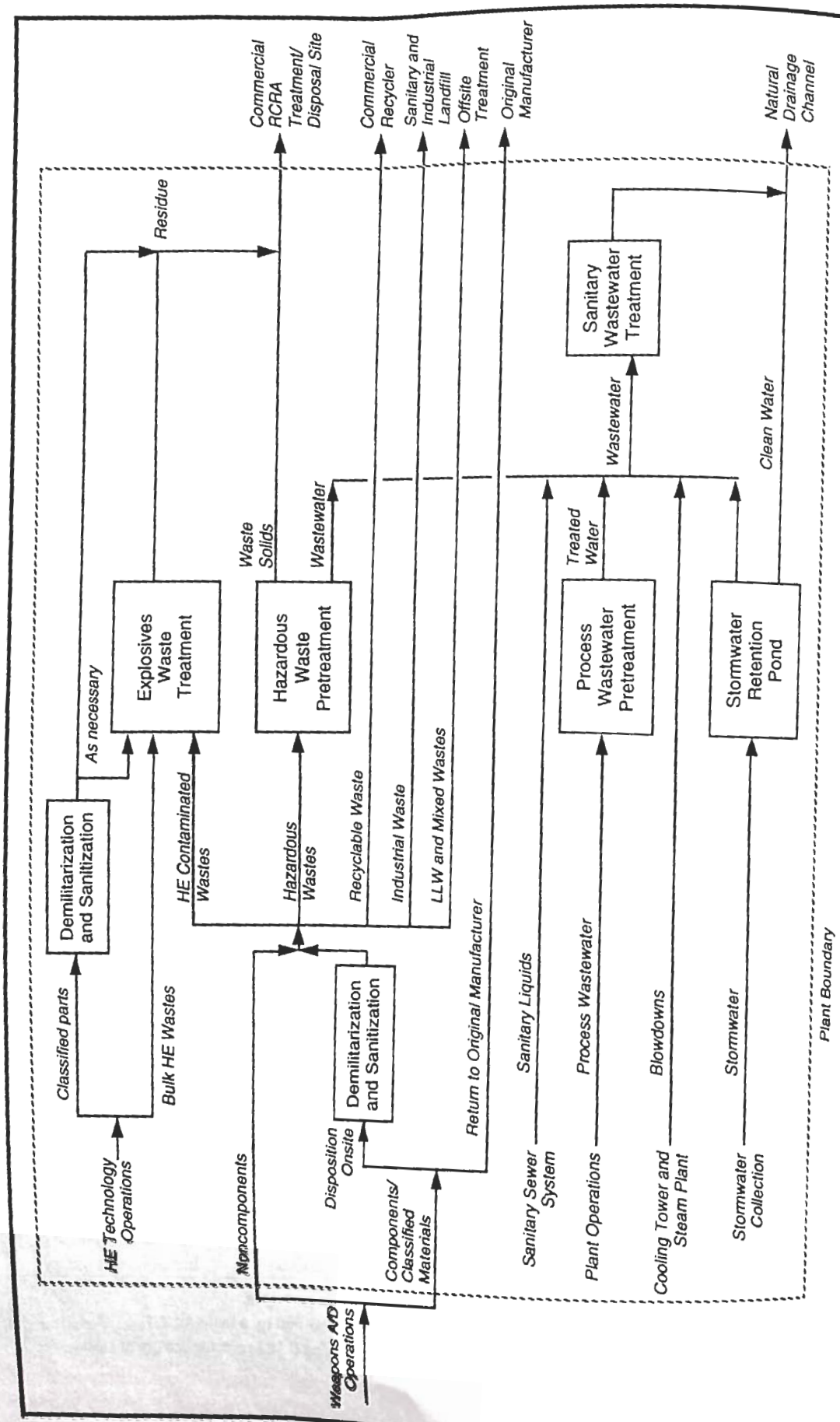
[a] Includes 9.2 m^3 generated from A/D operations and 11.3 m^3 generated from pit reuse operations.

[b] Assumes 2/3 of solid LLW is compactible by a factor of 4:1 and the liquid LLW is solidified by a factor of 2:1.

[c] Includes 4.6 m^3 of concrete and 0.6 t (0.7 tons) of steel. Volume estimate made by using 0.127 m^3/t for density of steel.

[d] Assumes 2/3 of solid is compactible by a factor of 4:1.

Source: PX 1995a:6; PX DOE 1995k; PX MH 1995a.


Commercial RCRA Treatment/ Disposal Site
Commercial Recycler
Sanitary and Industrial Landfill
Offsite Treatment
Original Manufacturer
Natural Drainage Channel
Residue
As necessary
Explosives Waste Treatment
Hazardous Waste Pretreatment
Waste Solids
Wastewater
Sanitary Wastewater Treatment
Wastewater
Clean Water
Treated Water
Process Wastewater Pretreatment
Stormwater Retention Pond
Demilitarization and Sanitization
Classified parts
Bulk HE Wastes
HE Technology Operations
HE Contaminated Wastes
Hazardous Wastes
Recyclable Waste
Industrial Waste
LLW and Mixed Wastes
Return to Original Manufacturer
Sanitary Liquids
Process Wastewater
Blowdowns
Stormwater
Noncomponents
Disposition Onsite
Demilitarization and Sanitization
Components/ Classified Materials
Sanitary Sewer System
Plant Operations
Cooling Tower and Steam Plant
Stormwater Collection
Weapons M&D Operations
Plant Boundary

reduce hazardous and toxic elements before discharge or transport. All fire-sprinkler water discharged in process areas is contained and treated as process wastewater, when required.

Low-Level Waste. LLW generated from the recertification, requalification, and reuse operations would consist of tubes removed from the pits, personnel protective equipment, glove box gloves, filters, cleaning materials, and disposal supplies. Small amounts of LLW would be generated by A/D operations and would consist primarily of sanitized and demilitarized weapon parts, test residue, compacted wipes, rubber gloves, and vacuum filters. Compactible LLW would be processed at the solid waste compaction facility. Compactible and noncompactible waste would then be shipped to NTS or a commercial vendor for disposal. Liquid LLW, consisting of solvents used in cleaning operations, would be solidified prior to packaging.

Mixed Low-Level Waste. Pit recertification, requalification, and reuse operations would not generate any mixed LLW. Small amounts of mixed LLW would be generated from operation of the A/D facility and would consist primarily of sanitized and demilitarized weapons parts, test residue, compacted wipes, rubber gloves, and vacuum filters. Mixed waste would be stored onsite in RCRA-permitted facilities and shipped to an offsite commercial facility for processing. Liquid mixed waste would be managed in accordance with the Pantex Site Treatment Plan.

Hazardous Waste. Liquid hazardous wastes would be generated from solvents from cleaning operations and residue from painting and bonding operations, as well as sanitized and demilitarized parts. The cleaning solvents selected would be from a list of nonhalogenated solvents. Hazardous liquids would be sent to one of three onsite wastewater treatment facilities. The treated nonhazardous effluent would be discharged in accordance with NPDES permits. Hazardous effluents would be packaged and shipped offsite to a RCRA-permitted treatment, storage, and disposal facility.

Solid hazardous wastes would be generated from nonradioactive materials such as wipes contaminated with oils, lubricants, and cleaning solvents that are used for equipment outside the main processing units. All HE and HE-contaminated substances would be returned to the HE fabrication site. All hazardous solid waste would be shipped to a RCRA-permitted facility for disposal.

Nonhazardous (Sanitary) Waste. Sewage wastewater and process wastewater would be treated in the sanitary wastewater treatment facility. Most of the treated effluent would be recycled for use in the cooling tower and other processes. Excess effluent would flow into a lagoon which then either evaporates or leaches into the ground. The sludge and other nonrecyclable, nonhazardous solid sanitary and industrial wastes would be compacted and shipped to the city of Amarillo landfill for disposal.

Nonhazardous (Other) Waste. Small amounts of classified nonhazardous waste would be generated from operation of the A/D facility. This waste would be demilitarized and sanitized before disposal in a permitted landfill.

A.3.1.2 *Relocate to Nevada Test Site*

All functions described in section A.3.1 would be relocated to NTS in this alternative. Figure A.3.1.2–1 shows the location of NTS facilities. The proposed A/D plant site plan is shown in figures A.3.1.2–2 and A.3.1.2–3. The size, number, and arrangement of the plant building and support areas are conceptual and may change significantly as design progresses. The site plans are included to convey general layout information only.

The existing Device Assembly Facility would form the cornerstone of the A/D plant. All plant facilities located within the material access area either occupy existing buildings inside the Device Assembly Facility or are located in hardened new construction connected to the Device Assembly Facility. All plant facilities located within the limited area at the plant site (adjacent to the Device Assembly Facility) would be new construction.

Key facilities required to meet the mission of the A/D operations at NTS are listed in table A.3.1.2–1. The following sections describe the key facilities in more detail.

Assembly Cells. Four existing assembly cells in the Device Assembly Facility would support the manual A/D of a physics package. A fifth available cell

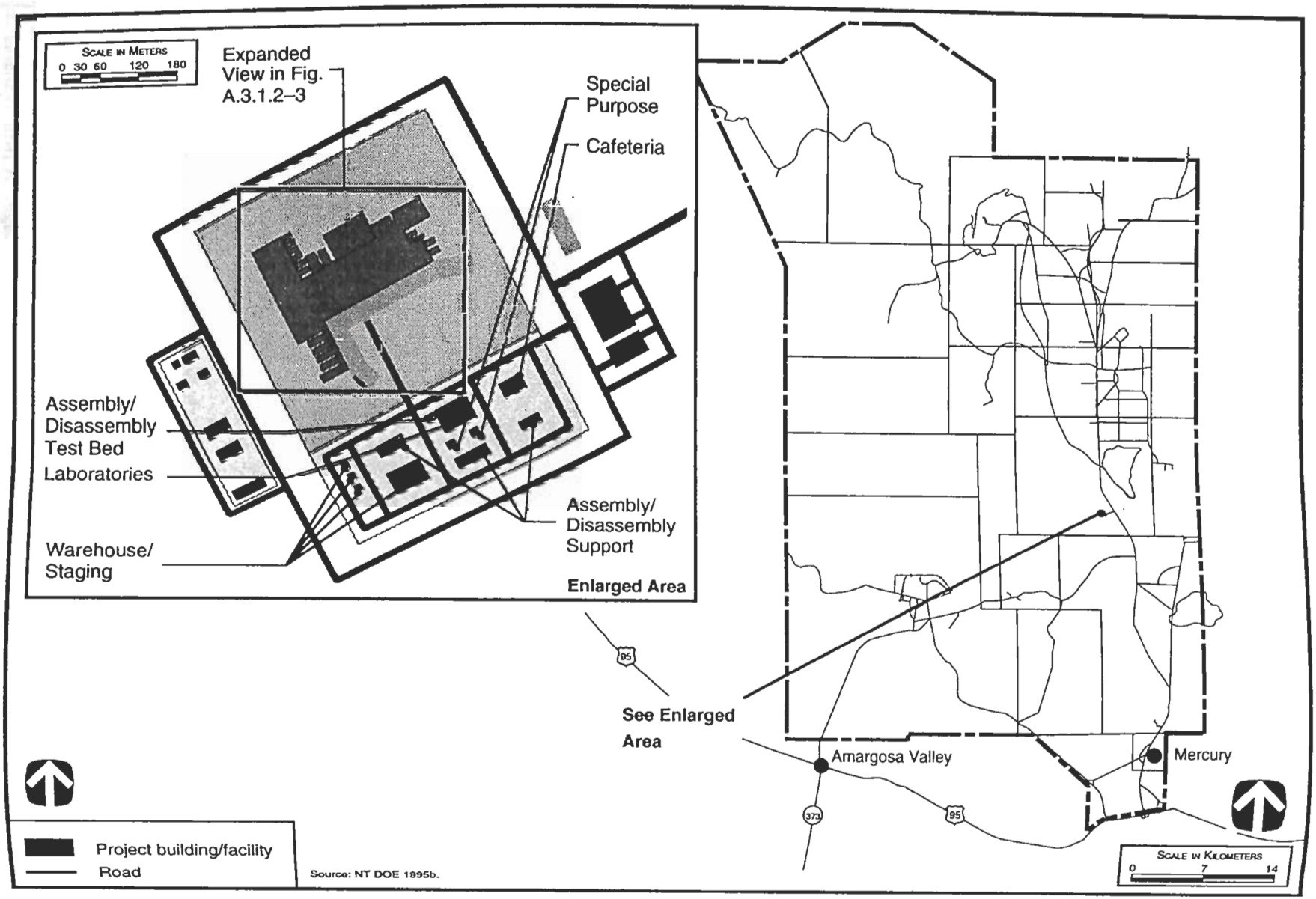


FIGURE A.3.1.2–1.—*Location of Facilities at Nevada Test Site.*

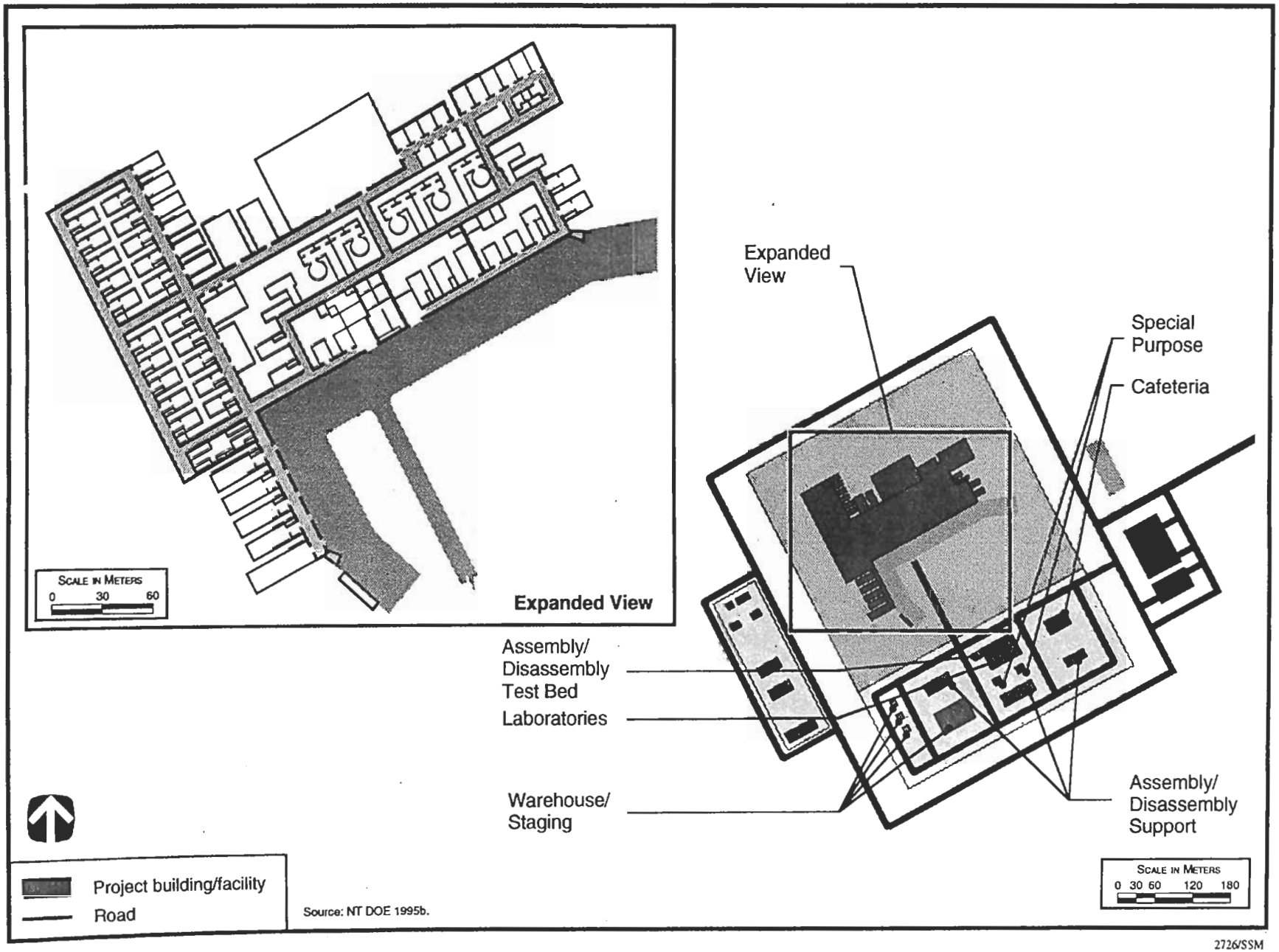
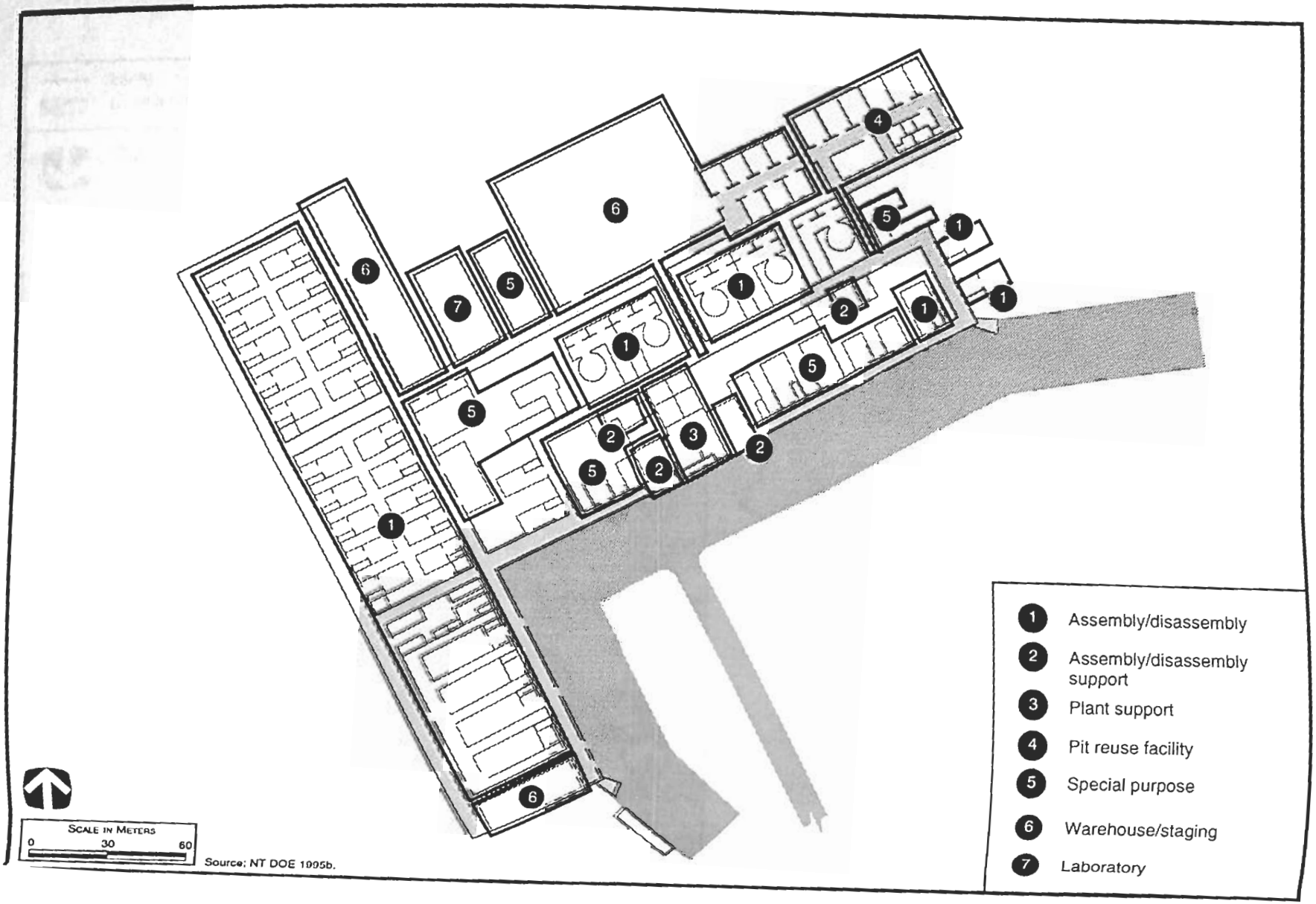


FIGURE A.3.1.2–2.—*Weapons Assembly/Disassembly Site Plan for Nevada Test Site.*



2727/SSM/App

...ded View) for Nevada Test Site.

TABLE A.3.1.2–1.—*Nevada Test Site Weapons Assembly/Disassembly Facility Data* [Page 1 of 2]

Building Number	Function	New or Existing	Location	Gross Area (m^2)	Construction Type	Number of Floors
Assembly/Disassembly						
DAF 301-304	Physics package cells	Existing	Material access area	1,732	Hardened concrete	1
DAF 341, 343, 345	Mechanical bays	Existing	Material access area	624	Hardened concrete	2
M01-M24	Mechanical bays	New	Material access area	6,044	Hardened concrete	2
L01	Test bed	New	Limited area	186	Steel	1
Laboratories						
23-700	Gas analysis lab	Existing	Area 23	828	Steel	1
L02	Weapons evaluation testing lab	New	Limited area	2,415	Steel	1
23-725	Metrology lab	Existing	Area 23	1,353	Steel	1
M51	Metrology lab	New	Material access area	557	Hardened concrete	1
23-190	Commercially procured material testing/staging	Existing	Area 23	701	Concrete	1
Warehousing/Staging						
L03	HE components	New	Limited area	279	Hardened concrete	1
23-160	Inert components/containers	New	Area 23	4,682	Steel	1
L04	Tooling/testers	New	Limited area	2,323	Steel	1
M26-M31	Weapons staging	New	Material access area	836	Hardened concrete	1
Special Purpose						
M32	Pit laser sampling	New	Material access area	46	Hardened concrete	1
M33	Accelerated aging	New	Material access area	372	Hardened concrete	1
L05	Special nuclear material container refurbishment/verification	New	Limited area	139	Steel	1
DAF 351, 353	AT-400 processing	Existing	Material access area	426	Hardened concrete	1
DAF 494	Mass properties	Existing	Material access area	118	Hardened concrete	1
DAF 492	Separations testing	Existing	Material access area	118	Hardened concrete	1
DAF 310	Vacuum chambers	Existing	Material access area	215	Hardened concrete	1
L06	Paint	New	Limited area	111	Steel	1
DAF 491	Permissive action link capability	Existing	Material access area	213	Hardened concrete	1
M34	Purge/backfill	New	Material access area	46	Hardened concrete	1
DAF 493	Component packaging	Existing	Material access area	118	Hardened concrete	1

TABLE A.3.1.2–1.—*Nevada Test Site Weapons Assembly/Disassembly Facility Data* [Page 2 of 2]

Building Number	Function	New or Existing	Location	Gross Area (m^2)	Construction Type	Number of Floors
Special Purpose (Continued)						
DAF 495	Component technical acceptance	Existing	Material access area	118	Hardened concrete	1
DAF 331, 332	Nondestructive evaluation	Existing	Material access area	744	Hardened concrete	1
M35	Nondestructive evaluation	New	Material access area	325	Hardened concrete	1
M52	Electronic testing	New	Material access area	325	Hardened concrete	1

Source: NT DOE 1995b.

would be held in reserve for test devices or expanded use if necessary. Each cell (standard Pantex design) includes an area to perform assembly operations, staging areas for special nuclear materials and weapon parts, and a mechanical room for heating, ventilation, and air conditioning equipment controls.

Assembly Bays. A new assembly bay facility would be constructed adjacent and connected to the Device Assembly Facility. This facility would contain 24 assembly bays; 20 of standard Pantex design and four with extended operational areas. Three additional bays of standard Pantex design are provided in the existing Device Assembly Facility. All assembly bays would be separated by a minimum of 4.1 m (13.6 ft) of earth fill for explosive blast shock mitigation. Each bay would include an area or areas to perform assembly operations, staging areas for tooling and weapon parts, and a second floor mechanical room for heating, ventilation, and air conditioning equipment and controls. Two additional assembly bays are held in reserve within the existing Device Assembly Facility for device assembly operations or expanded use, if required.

Test Bed. A new nonhardened facility would be constructed within the limited area, adjacent to the Device Assembly Facility for test bed fabrication. This facility would contain universal assembly bays configured with program-specific tooling.

Laboratories

Gas Analysis. Gas analysis would be performed in an existing nonhardened building in Area 23. This building would be configured with laboratory facilities equipped to provide analysis by gas fractionation, gas chromatography, and mass spectrometry.

Weapons Evaluation Testing. A new nonhardened facility would be constructed within the limited area, adjacent to the Device Assembly Facility for weapons evaluation testing. This facility would contain a number of fully instrumented test stations to provide for heating, cooling, and test firing the test beds. A cryogenic system would be used for the cooling of these units during testing. Environmental conditioning ovens and centrifuges would be provided for the testing of components under deployment conditions.

Metrology. Metrology laboratory facilities would be located in an existing nonhardened building in Area 23 and in a new hardened building within the material access area, connected to the existing Device Assembly Facility. These facilities would be equipped to calibrate instruments and testers used in weapon assembly operations. A class 1000 clean room with heating, ventilation, and air conditioning temperature control to $\pm$ 2.8 °C ($\pm$ 5 °F) would be added to these buildings.

Commercially Procured Material Testing/Staging. An existing building located in Area 23 would be used to test and stage commercially procured materials used in the assembly process. This building would have both receiving and staging areas and a room equipped for performing standard material tests.

Special Purpose Bays

Pit Laser Sampling. A new hardened building would be constructed within the material access area, connected to the Device Assembly Facility, to perform laser sampling of pits.

Accelerated Aging. A new hardened building would be constructed within the material access area, connected to the Device Assembly Facility, to simulate accelerated environmental aging of newly produced weapons and weapon components. This building would contain five environmental chambers to provide thermal cycling above and below ambient temperatures for an extended period of time.

Special Nuclear Materials Container Refurbishment/Verification. A new building would be constructed within the limited area, adjacent to the Device Assembly Facility, to refurbish and verify processing of special nuclear material containers.

AT-400A Processing. Two existing hardened bays within the Device Assembly Facility would be used for AT-400A processing.

Mass Properties. Mass properties determination would be performed in an existing hardened bay within the Device Assembly Facility. This building would be equipped with remotely operated dynamic balancing machines to determine products of inertia and lateral center of gravity and a center of gravity and moments of inertia machine.

Separations Testing. An existing hardened bay in the Device Assembly Facility would be used for separa-

tions testing. This bay would be equipped to test selected reentry body subassemblies, measurements of service-related deterioration of the release assembly system, and for acquisition of data associated with the evaluation of release assembly hardware.

Vacuum Chambers. Two vacuum chambers would be installed in an existing hardened building in the Device Assembly Facility to perform leak rates on all outgoing weapons or on weapons returned from the field.

Paint. A new nonhardened building would be constructed within the limited area, adjacent to the Device Assembly Facility, to paint, repaint, or touch-up weapons, weapon components, and containers.

Purge/Backfill. A new hardened building would be constructed within the material access area, connected to the Device Assembly Facility, to conduct purge and backfill operations. This building would be equipped to either purge or fill the inside of the weapon case with a specific gas.

Component Packaging/Technical Acceptance. Component packaging and technical acceptance operations would be conducted in two existing hardened Device Assembly Facilities.

Nondestructive Evaluation. Explosive components would be inspected by linear accelerator, medium x ray, and computed tomography within the existing two radiography buildings in the Device Assembly Facility. Other weapon and component testing would be conducted in a new hardened building located within the material access area, connected to the Device Assembly Facility. This building would contain equipment to support mechanical conditioning tests including vibration, hostile shock, mini air-gun shock, and steady-state acceleration shock.

Electronic Testing. Electronic testing of weapon components would be conducted in a new hardened building located within the material access area, connected to the Device Assembly Facility.

Warehousing/Staging

High Explosives Components. Three new hardened bunkers would be constructed within the limited area, adjacent to the Device Assembly Facility, for the storage of HE components. These bunkers would b bermed and would provide a safe separation distan to all other occupied facilities at the plant site.

Special Nuclear Materials Components. A ne hardened building would be constructed within t material access area, connected to the Devic Assembly Facility, to stage and store special nucl material components. This building would conta segregated staging bays and inspection equipment a would utilize the existing safe secure trailer loadi dock within the Device Assembly Facility for secu receiving of special nuclear material components.

Inert Components/Containers Shipping and Rece ing. An existing building located in Area 23 would used to ship, receive, and store inert weapon com nents. This facility would include storage racks loading dock, and areas designed for packaging a unpackaging.

Tooling/Testers. A new nonhardened building wo be constructed within the limited area, adjacent to existing Device Assembly Facility, to control storage of precision tools, instruments, testers, a special equipment used in A/D operations. Seg gated storage areas would be provided for all spec tooling requirements supporting weapons progra in the enduring stockpile.

Weapons. Six new hardened bays would be c structed within the material access area, connecte the Device Assembly Facility, for the interim stag of a maximum of 100 weapon units. This faci would have a dedicated safe secure trailer dock shipping and receiving weapons.

Strategic Plutonium/Canned Subassem Storage. The strategic Plutonium/Canned Su sembly Storage Facility would consist of hardened construction within the material access connected to the existing Device Assembly Facil

Weapons A/D facilities construction would ta years to complete. Materials and resou consumed during the entire construction perio listed in table A.3.1.2–2.

The principal sources of air emissions during facility construction would be fugitive dust from clearing, site preparation, excavation, and other

struction activities, and exhaust from construction equipment and vehicles. The annual emissions generated during a 1-year period with peak construction activity are shown in table A.3.1.2–3.

TABLE A.3.1.2–2.—*Nevada Test Site Weapons Assembly/Disassembly Construction Materials/Resources Requirements*

Material/Resource	Total Consumption	Peak Demand[a]
Electricity	38,000 MWh	5 MWe
Water	98,400,000 L	94,600 L/day
Concrete (m^3)	75,000	
Steel (t)	16,300	
Liquid fuel and lube oil (L)	3,030,000	
Industrial gases (m^3)[b]	65,100	

[a] Peak demand for electricity is the maximum rate. Peak demand for water is the average daily consumption during a 1-year period with peak construction activity.

[b] Cubic meters measured at standard temperature and pressure.

Source: NT DOE 1995b.

TABLE A.3.1.2–3.—*Nevada Test Site Weapons Assembly/Disassembly Construction Emissions*

Pollutant	Quantity (t)
Sulfur dioxide	1.8
Nitrogen dioxide	24
Volatile organic compounds	7.3
Carbon monoxide	36
Particulate matter	13.6
Total suspended particulates	31

Source: NT DOE 1995b.

The number of craftworkers, as well as construction management and support staff, required during each year of construction, are presented in table A.3.1.2–4.

The utilities consumed during operation include electric power, liquid fuels, and water. Annual utility consumption rates and peak electric power rates for surge operation are shown in table A.3.1.2–5.

The chemicals and materials consumed during operation primarily include water treating chemicals, reactants and solvents for explosives formulation and synthesis, explosive powders, materials for facility equipment and vehicle maintenance, metals for manufacturing tooling, and bottled gases. Annual surge operation material consumption is listed in table A.3.1.2–6.

Emissions. Gaseous environmental releases result from operation of the thermal treatment unit for nonradioactive HE contaminated waste and mixed HE contaminated waste. Emissions will also result from plant boiler operation, cleaning operations using solvents, and small scale synthesis operations. The thermal treatment units would be designed and operated to attain and maintain temperatures that result in the destruction of hazardous constituents and hazardous particulates that will be trapped in filters. The releases will be limited to what is possible using the best available control technology. The annual emissions for the A/D facility surge operations are shown in table A.3.1.2–7.

Waste Management. NTS waste management is described in detail in appendix section H.2.8. The liquid and solid nonhazardous wastes generated during the 6-year construction period would include concrete and steel construction waste materials and sanitary wastewater. The steel construction waste would be recycled as scrap material before completing construction. The remaining nonhazardous wastes generated during construction would be disposed of as part of the construction project by the contractor. Uncontaminated wastewater would be used for soil compaction and dust control, and excavated soil would be used for grading and site preparation. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes generated during construction would consist of such materials as waste adhesives, oils, cleaning fluids, solvents, and coatings. Hazardous waste would be packaged in DOT-approved containers and shipped offsite to commercial RCRA-permitted treatment, storage, and disposal facilities. No radioactive waste would be generated during construction.

The project design incorporates waste minimization and pollution prevention. Segregation of activities that generate radioactive and hazardous wastes would be employed, where possible, to avoid the generation of mixed wastes. Where applicable, treatment to separate radioactive and nonradioactive components would be performed to reduce the

TABLE A.3.1.2–4.—*Nevada Test Site Weapons Assembly/Disassembly Construction Workers*

Employees	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Total
Craftworkers							
Carpenter	61	117	115	63	41	36	433
Concrete mason	8	15	10	2	2	4	41
Electrician	24	27	53	90	96	55	345
Iron worker	30	75	67	23	16	16	227
Laborer	38	62	52	20	17	20	209
Millwright	3	7	10	20	19	7	66
Operator	10	23	29	22	18	9	111
Sheet metal worker	5	14	29	29	14	5	96
Pipe fitter	15	32	75	82	78	32	314
Sprinkler fitter	3	8	16	16	7	3	53
Teamster	3	6	7	7	6	3	32
Other craftworkers	4	8	15	24	20	6	77
Total Craftworkers	204	394	478	398	334	196	2,004
Construction staff[a]	29	59	73	61	51	30	302
Management and support staff[b]	44	91	111	92	78	46	462
Total Employment	277	544	662	550	463	272	2,768

[a] Construction staff includes temporary construction facilities, construction services, and field staff.

[b] Management and support staff include all construction personnel and an allowance for DOE site personnel, field and vendor inspection services, construction management, and engineering support during construction.

Source: NT DOE 1995b.

TABLE A.3.1.2–5.—*Nevada Test Site Weapons Assembly/Disassembly Facility Surge Operation Annual Utility Requirements*

Utility	Consumption	Peak Demand[a]
Electricity	45,000 MWh	7 MWe
Liquid fuel (L)	432,000	
Natural gas (m^3)	3,680,000	
Water (L)	98,400,000	

[a] Peak demand is the maximum rate expected during any time.

Source: NT DOE 1995b; NTS 1995a:2.

TABLE A.3.1.2–6.—*Nevada Test Site Weapo Assembly/Disassembly Facility Surge Operation Annual Chemical Requiremen*

[Page 1 of 2]

Chemical	Quantity (kg)
Acetone	64
Acetonitrile	64
Aluminum metal	499
Argon	8,165
Brass metal	50
Carbon dioxide	49,896
Circlene FG 20	227
Clepox 143	227
Copper/copper oxide wire	295
Copper metal	136
Degreaser	227
Dispersant	68
Dry air	771
Eco-Star	726
Electrode/probe solutions	59
Ethyl alcohol	59
Fixer/replenisher	454

volume of mixed wastes and provide for cost effective disposal or recycle. To facilitate waste minimization, where possible, nonhazardous materials would be substituted for those materials which contribute to the generation of hazardous or mixed waste. Production processes would be configured with minimization of waste production given high priority. Material from the waste streams would be treated to facilitate disposal as nonhazardous wastes, where possible. Future D&D considerations have also been incorporated into the design.

TABLE A.3.1.2–6.—*Nevada Test Site Weapons Assembly/Disassembly Facility Surge Operation Annual Chemical Requirements* [Page 2 of 2]

Chemical	Quantity (kg)
Glass cleaner	454
Glass beads	136
Helium	1,769
Heptane	113
Hydraulic/lubricating oil	8,165
Hydrochloric acid	68
Joint compound	363
Kimwipes	1,134
Lead metal	136
Micro liquid lab cleaner	113
Mild steel metal	1,814
Molecular sieve	295
Neutrasorb acid neutralizer	68
Nitrogen	3,629
Paint	4,536
Planisol-M concentrate	113
Polyalkylene and ethylene glycol	68
Potassium hydroxide	113
Siliconized ammonium phosphate base	181
Sodium hydroxide	113
Solksorb solvent absorbent	499
Specialty gas mixtures	1,542
Stainless steel metal	612
Sulfuric acid	113
Tetrahydrofuran	4,990
TISAB and CDTA	250
Toluene	68
Water treating chemicals	2,268

Source: NT DOE 1995b; NTS 1995a:3.

TABLE A.3.1.2–7.—*Nevada Test Site Weapons Assembly/Disassembly Facility Surge Operation Annual Emissions*

Pollutant	Quantity (t)
Carbon monoxide	0.007
Nitrogen dioxide	0.907
Particulate matter	0.00227
Sulfur dioxide	0.907

Source: NT DOE 1995b; NTS 1995a:3.

Table A.3.1.2–8 presents the estimated annual waste volumes from the A/D and pit reuse facility during construction and surge operations. Liquid and solid waste streams are routed to the waste management system. Solid wastes would be characterized and segregated into LLW, hazardous and mixed wastes, then treated to a form suitable for disposal or storage within the facility. Liquid wastes would be treated onsite to reduce hazardous and toxic and radioactive elements before discharge or transport. All fire-sprinkler water discharged in process areas is contained and treated as process wastewater, when required.

Low-Level Waste. LLW generated from reuse operations would consist of tubes removed from the pits, personnel protective equipment, glove boxes, filters, cleaning materials, and disposal supplies. Small amounts of LLW would be generated by A/D operations and would consist primarily of sanitized and demilitarized weapon parts, test residue, compacted wipes, rubber gloves, and vacuum filters. Bulk waste would be disposed of in Area 3, and packaged waste would be disposed of in Area 5, employing standard shallow land burial techniques.

Mixed Low-Level Waste. Pit reuse operations would not generate any mixed LLW. Small amounts of mixed LLW would be generated from operation of the A/D facility and would consist primarily of sanitized and demilitarized weapon parts, test residue, compacted wipes, rubber gloves, and vacuum filters. Mixed LLW would be stored in an onsite RCRA-permitted storage facility until treatment in accordance with the site treatment plan that was developed to comply with the *Federal Facility Compliance Act* of 1992.

Hazardous Waste. Liquid hazardous wastes would be generated from solvents from cleaning operations and residue from painting and bonding operations. The cleaning solvents selected would be from a list of nonhalogenated solvents. Solid hazardous wastes would be generated from nonradioactive materials, such as wipes contaminated with oils, lubricants, and cleaning solvents that are used for equipment outside the main processing units. Hazardous wastes would be collected in DOT-approved containers and sent to an onsite hazardous waste storage area. The hazardous waste storage area would provide a 90-day staging capacity prior to shipment to an offsite com-

TABLE A.3.1.2–8.—*Nevada Test Site Weapons Assembly/Disassembly Facility Waste Volumes*

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations (m^3)	Annual Volume Effluent from Surge Operations (m^3)
Low-Level			
Liquid	None	0.06	None
Solid	None	30[a]	15[b]
Mixed Low-Level			
Liquid	None	None	None
Solid	None	2	2
Hazardous			
Liquid	None	6	6
Solid	5	0.05	0.05
Nonhazardous (Sanitary)			
Liquid	6,670	53,000	53,000
Solid	260[c]	100	50[d]
Nonhazardous (Other)			
Liquid	Included in sanitary	Included in sanitary	Included in sanitary
Solid	Included in sanitary	Included in sanitary	Included in sanitary

[a] Includes 18.3 m^3 generated from A/D operations and 11.3 m^3 generated from pit reuse operations.
[b] Assumes 2/3 of solid LLW is compactible by a factor of 4:1 and the liquid LLW is solidified by a factor of 2:1.
[c] Includes 255 m^3 of concrete and 39 t (43 tons) of steel. Volume estimate made by using 0.127 m^3/t for density of steel.
[d] Assumes 2/3 of solid is compactible by a factor of 4:1.
Source: NT DOE 1995b; NT DOE 1995f; NTS 1995a:2; NTS 1995a:3; PX DOE 1995k.

mercial RCRA-permitted treatment, storage, and disposal facility, using DOT-certified transporters.

Nonhazardous (Sanitary) Waste. Sewage wastewater and process wastewater would be treated using a series of facultative lagoons and evaporation ponds and disposed of in septic tanks, sumps, or ponds. Solid wastes are disposed of in landfills at vari locations on the site.

Nonhazardous (Other) Waste. Small amounts classified nonhazardous waste would be gener from operation of the A/D facility. These wa would be sanitized and disposed of per site practi

A.3.2 Secondary and Case Fabrication

This alternative involves those activities required to support the production and maintenance of the secondaries and case components of the nuclear weapons physics package as follows:

- Providing secondary materials
- Processing materials
- Fabricating parts and components
- Assembling and disassembling secondary components
- Performing quality evaluations of secondary assemblies
- Providing safe secure storage of secondary material and products

Functional capabilities required to perform these activities include operations to physically and chemically process, machine, inspect, assemble, certify, disassemble, and store secondary materials. Management of wastes generated from these operations is also required. The fabrication of secondaries and cases can be subdivided into the following major material production processes: uranium, lithium, and nonnuclear/special materials. The following typical process descriptions are provided to illustrate the functional activities and operations associated with each of the major production processes. These processes are based on traditional secondary and case fabrication methods and represent upper bounds to the types and number of processes that would be continued in the downsized and reconfigured Complex. Alternative sites for performing secondary and case fabrication are Y-12, LANL, and LLNL. The site-specific descriptions provided in sections A.3.2.1 to A.3.2.3 are based on more streamlined and less unit operations than described in this section. When comparing data between site alternatives, it is important to note that there are differences in the facility designs. The Y-12 alternative considers all the necessary support facilities to conduct the missions, not just the production and storage facilities. The LANL and LLNL alternatives only consider the incremental changes for operating the production facilities. The actual production footprint size of each alternative is almost identical; however, the production capacities vary between site alternatives. For example, base case, multiple-shift capacities at Y-12 and LANL are about 150 units, whereas at LLNL the equivalent production capability would be about 50 units. This creates significant differences in some of the data.

Process Descriptions

Uranium. The uranium process provides finished uranium parts and products. The operations are capable of all uranium handling and processing functions, from raw materials handling to finished parts manufacturing. In addition, uranium storage areas need to be provided for storage of in-process uranium materials and, at ORR only, for the HEU strategic reserve. In the event secondary and case fabrication is phased out at ORR and performed at LANL or LLNL, the storage of the HEU strategic reserve would be addressed at the weapons A/D site (i.e., Pantex or NTS).

The production of uranium parts and products involves casting or wrought processing; metalworking; machining, inspection, and certification; chemical recovery; assembly, disassembly, and quality evaluation; and in-process storage. The products from casting or wrought processing are billets and cast parts that feed directly to machining and metalworking. Billets are cropped and cast parts are delugged before they are sent to the next operation. The input to casting consists of retired weapons parts, metal buttons from storage, and recycled scrap metal from metalworking and machining. A casting charge is made up and processed in a critically safe configuration in a vacuum induction furnace. Scrap metal and machine turnings are degreased, cleaned, and briquetted before direct recycle.

Metalworking prepares a wrought product as feed for machining. Cropped billets from casting are preheated in a salt bath, rolled into a sheet, annealed in a salt bath, blanked, and pressed. The blanking operations are a major source of recycled metal for casting. Formed parts are cleaned, debrimmed, and machined.

Both formed and cast blanks are machined to finished dimensions and inspected. Scrap metal and machine turnings are returned to casting for cleanup and reuse.

Miscellaneous solids are sent to the chemical recovery systems for treatment to recycle the material back to metal buttons. Product inspections and certification is accomplished with coordinate measuring machines, optical gaging, high-energy x-ray radiography, ultrasonic and dye penetrant flaw-inspection methodology, plating thickness gaging, and mechanical properties testing.

Uranium chemical recovery receives feed from virtually all areas in the process. The major feeds are residuals from casting, impure metal chips from machining, and a miscellaneous array of combustibles from all areas. The feeds are incinerated and processed in a head-end treatment consisting of acid dissolution, leaching, and feed preparation for solvent extraction. The feed solution is processed through primary extraction by which it is purified, concentrated by evaporation, and purified further by secondary extraction. The resulting solution is converted to oxide, then to uranium tetrafluoride, and then to uranium metal buttons. Secondary residues are returned to the head-end treatment. Finished metal is returned to casting for reuse.

Assembly operations assemble piece parts into subassemblies using joining techniques such as welding, adhesive bonding, and mechanical joining. Disassembly takes retired weapons apart and recycles all materials of value. The quality evaluation function receives weapons from the stockpile for disassembly, evaluation, and lifecycle testing. Shipping containers for weapons parts and subassemblies are certified and refurbished as part of the A/D process.

Uranium storage includes storage vaults for in-process uranium materials, which includes buttons and other scrap materials directly recycled, as well as semi-finished and finished components. The vaults at ORR are also for the strategic reserve, which includes assembled secondaries and HEU metal castings.

Lithium. The lithium process provides finished lithium hydride and deuteride parts. Primary functional elements of this process include powder production and forming, finishing and inspection, and deuterium production. These systems are briefly described below.

The lithium hydride and deuteride from storage, recycled weapons parts, and manufacturing scrap are broken, crushed, and ground to produce powder. ' powder is loaded into molds and cold isostatica pressed to form solid blanks.

The blanks are unloaded from the molds and pla into vacuum furnaces where they are outgassed heating under vacuum. After cooling, the outgas blanks are loaded into form-fitting bags, heated, a then warm pressed. After being warm pressed, t blanks are cooled to room temperature and remov from the bags. The fully dense machining blanks t result from forming operations are radiographed detect any high-density inclusions. Powder produ tion, mold loading, and radiography are a performed in dry glove boxes to minimize reaction the lithium hydride and deuteride with moisture the atmosphere. Mold unloading, furnace loadi and unloading, and bag loading and unloading are conducted in an inert glove box. The lithium hydri or deuteride is handled outside inert-atmosphe glove boxes only when it is sealed in a mold or ba

The blanks from forming operations are machined final shapes and dimensions on lathes using singl point machining methods in finishing operation Most machine dust is collected for direct recycl salvage operations. The finished part weight an dimensions are inspected using certified balances an contour measuring machines. All machining an inspection activities are conducted in dry glove boxe to minimize any reaction with moisture in the atmo sphere. Certified parts receive a final vacuum outgas sing treatment before final assembly.

Deuterium is required for many of the products an will be stored for future use. Deuterium oxide, o heavy water, is electrolytically reduced. The resulting deuterium is compressed and stored for use. The compressed deuterium gas is used to reconver the lithium metal to deuteride in the final step of wet chemistry if needed.

Lithium wet chemistry can be used to pre-produce lithium hydride and deuteride to meet production requirements for many decades. The principal function of wet chemistry is to purify lithium hydride and deuteride by removing oxygen and other trace elements. The principal feeds to this system are retired weapon components from the disassembly operation, machine dust, powder, and killed parts from other operations. Purification is accomplished by transforming the lithium hydride and deuteride

through a chemical dissolution process; then the solution is evaporated and crystallized. The crystals are then reduced to lithium metal and impurities are removed. The lithium metal is then reconverted to lithium hydride and deuteride by combining it with hydrogen or deuterium gas. The resulting lithium hydride and deuteride billet, sealed in a thin stainless-steel can, is transferred to lithium storage.

The production of lithium hydride and deuteride components creates a considerable amount of scrap that must be recycled to recover the lithium and deuterium. Much of the machine dust, unacceptable formed parts, machined parts that fail inspection, and stockpile returned parts are directly recycled. Salvage operations typically process material that is too impure to be recycled. Salvage operations primarily involve washing and chemical recovery. Items that require washing include machining tools and fixtures, filters used throughout the processes, and sample bottles. Oil-soaked lithium hydride and deuteride blanks from the powder-forming operations are also prepared for storage. Solutions from the purification and wash operations, including mop and dike water streams, are neutralized, filtered, crystallized, and sent to storage or waste disposal.

Long-term storage is required for chemicals and preproduced lithium hydride and deuteride billets. Interim storage is to be provided for lithium hydride and deuteride components from disassembly or retired weapons and rejected components from forming and finishing operations.

Special Materials. Special materials such as diallyl-phthalate are required to support the lithium processes. Diallyl-phthalate based molding compound is formed into near-net-shape blanks that are later machined to finished parts. The primary forming operation is compression or transfer molding, which is followed by a drying and final curing step.

Nonnuclear. The nonnuclear process is responsible for producing certain weapon components composed of nonnuclear materials and for providing the uranium and lithium processes with specialized material and support services. Many types of materials are processed to provide a diverse product line consisting of both nonnuclear metal components and tooling and a variety of polymer-based items. The principal manufacturing technologies employed are hydroforming, hydrostatic forming, rolling, forging, heat treating, welding, machining, cold/hot isostatic pressing, grinding, winding, casting, plating, molding, and coating.

The nonnuclear process handles several product streams, which are described briefly in the following paragraphs.

Several types of urethane foams are required to be produced. The urethane components and blowing agents are pumped into molds and allowed to expand to fill the mold. After curing, the foam moldings are ejected and trimmed to final shape.

Steel and aluminum are construction materials for both components and support tooling, making this a relatively high throughput product line. The usual fabrication route for both materials is rough machining, heat treatment, and finish machining.

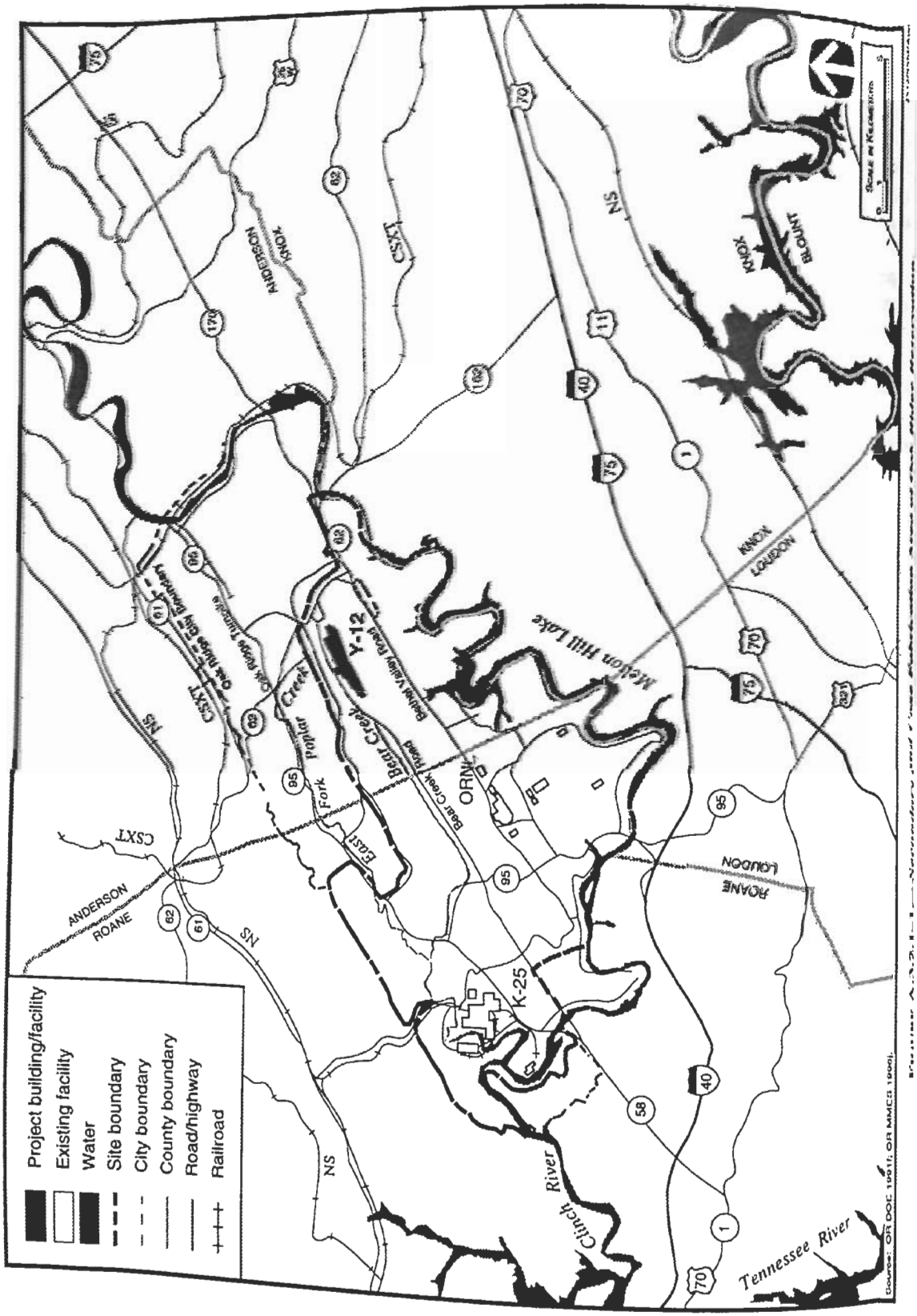
Operations to produce stainless steel cans consist of blanking, followed by hydroforming and hydrostatic forming with subsequent machining and heat treatment. Ultrasonic cleaning is required before heat treatment to ensure cleanliness for welding, which completes the assembly.

Ceramic finished parts are finished from blanks or procured. Procured parts are inspected and certified prior to final assembly.

Polyvinyl chloride is formed into bags and castings and also applied as a coating. Items to be coated are dipped into a tank of curable, plasticized polyvinyl chloride formulation, whereas castings are produced by transferring the polyvinyl chloride liquid into a mold. All items are heat cured.

A.3.2.1 *Downsize at Oak Ridge Reservation*

Y-12 has performed the secondary and case fabrication mission in the Complex for over 40 years. This mission includes the production of materials and components for thermonuclear weapons secondary assemblies and the associated functions such as depleted uranium for radiation cases and other miscellaneous materials for other applications. Figure A.3.2.1–1 shows the location of Y-12 at ORR.


Project building/facility
Existing facility
Water
Site boundary
City boundary
County boundary
Road/highway
Railroad
Y-12
K-25
ORNL
Melton Hill Lake
Clinch River
Tennessee River
Bear Creek
Poplar Creek
East Fork
Bear Creek Road
Bethel Valley Road
Oak Ridge Turnpike
Oak Ridge City Boundary
ANDERSON
ROANE
KNOX
LOUDON
BLOUNT
CSXT
NS

The Y-12 secondary and case fabrication mission requires approximately 30 ha (75 acres) of the existing 328-ha (811-acre) Y-12 site. This, unlike the LANL and LLNL alternatives, includes significant area for support facilities. There would be no new developed land outside the currently existing Y-12 boundary. Land for construction laydown and warehousing would be minimal and would use existing Y-12 developed areas; construction parking requirements, about 0.8 ha (2 acres), can be satisfied by existing unused parking facilities.

The Y-12 complex consists of an array of production and support facilities. The physical configuration for the Y-12 secondary and case fabrication mission consists of five main production buildings, one shared production facility, and a number of office, utility, and changehouse facilities.

During the past 12 years, major restoration projects (such as Production Capability Restoration, Utility System Restoration, and the Capability Assurance Program) have brought the infrastructure supporting this facility up to current standards and should allow the use of these facilities for up to an additional 40 years. Figure A.3.2.1–2 is a plot plan of Y-12 showing these main and shared facilities.

The secondary and case fabrication mission would be located in the following Y-12 production buildings: 9996, 9212, 9215, 9201-5N, 9204-2E, 9204-2 (isostatic press), 9720-19, and 9998. The secondary and case fabrication mission footprint comprises 61,800 m^2 (665,000 ft^2) of total DP area including a production footprint of 21,840 m^2 (235,000 ft^2). The total proposed footprint includes all DP functions: production, storage, maintenance, dedicated utilities, and administration. Buildings 9204-2 and 9201-5W would be placed in cold standby to enable reactivation in the event of unforeseen additional capacity demands. Activation of these buildings would require separate NEPA evaluation.

The following production buildings would be used to support the Stockpile Stewardship and Management Program.

Building 9212

- E-wing—Enriched uranium casting and storage would continue in this area. All but two of the west line casters would be placed in standby as would one auxiliary caster. Adjacent to E-wing is the process area for enriched uranium metal recovery, which would be operated by programs other than DP or placed in cold standby.

- A2-wing—This wing would be used as now configured for depleted uranium and binary operations.

- Equipment for metal production from uranium oxide would be held in cold standby.

Building 9998

- Foundry—The staging area and six furnaces would be used.

- H2-Area—This area would contain all of the enriched uranium machining and the associated dimensional inspection. The existing storage area would remain, and G3-Area would be used for ceramic machining and other special materials.

- F-Area—This area would be used in its current configuration for depleted uranium binary and nonnuclear metalworking with the 3,175 t (3,500 ton) press added.

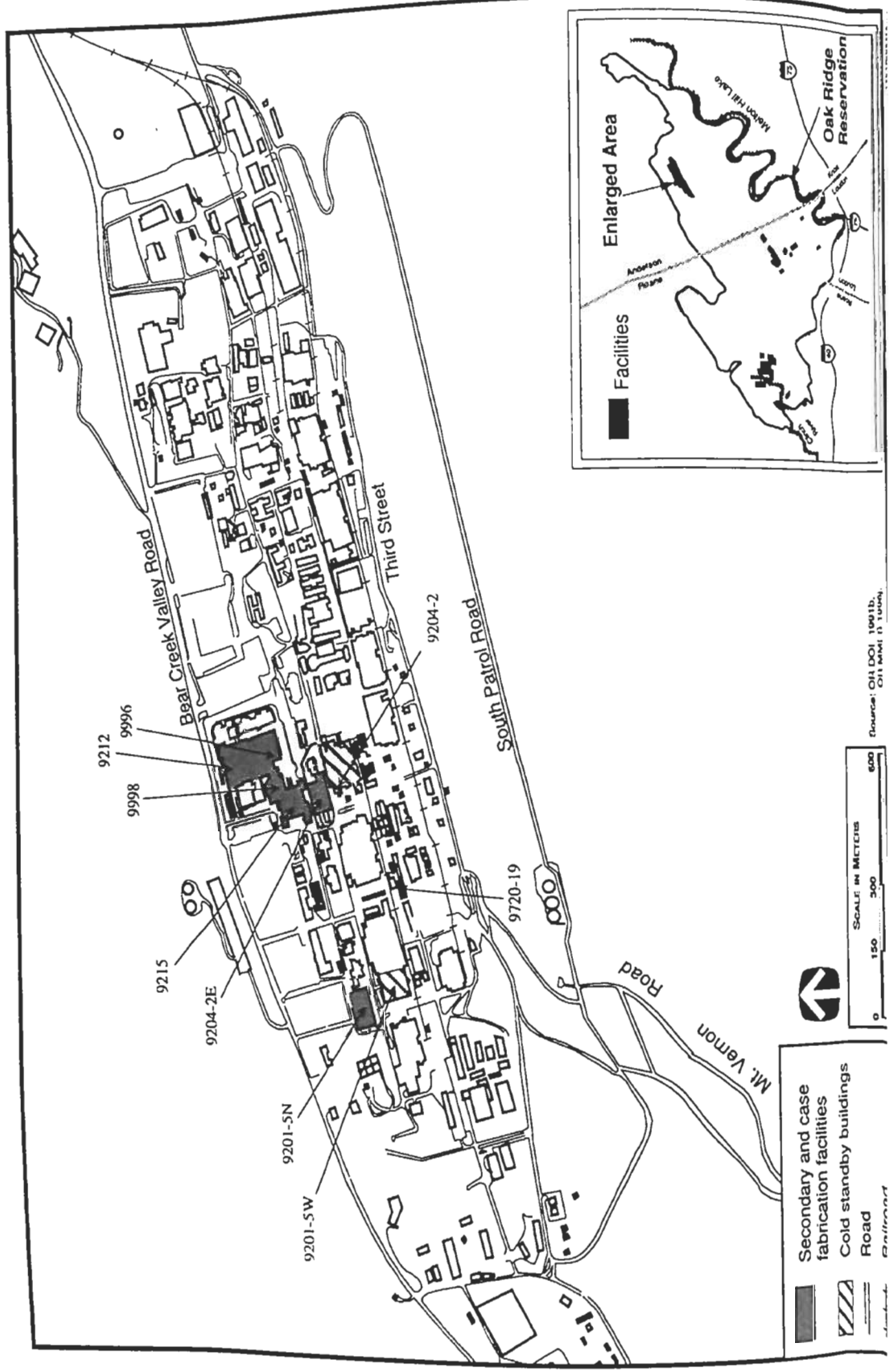
Building 9215

- M-wing—This area would be used for enriched uranium storage.

- O-wing—Enriched uranium rolling and forming would be performed in this area.

- P-wing—This area would continue to be used for hydroforming and would house the can shop, relocated from Building 9210-1.

- N-wing—The third mill area would continue to function as the depleted and alloyed uranium rolling and blanking operation.


Enlarged Area
Facilities
Oak Ridge Reservation
Bear Creek Valley Road
Third Street
South Patrol Road
Mt. Vernon Road
9212
9996
9998
9215
9204-2E
9204-2
9720-19
9201-5N
9201-5W
Secondary and case fabrication facilities
Cold standby buildings
Road
Scale in Meters
0
150
300
600

Building 9996

- This building would be used as a laydown and tool storage area for the equipment now in service in the Building 9212-A2 Area and the F-Area of Building 9998.

Building 9204-2

- The largest isostatic press would continue to be used for the lithium forming operation. This press is in a self-contained small section of Building 9204-2 that would be sealed. The remainder of Building 9204-2 would be placed in cold standby.

Building 9201-5N

- This building houses machine tools and other preparation and plating equipment dedicated to the production of depleted uranium/binary alloy/nonnuclear components.

Building 9201-5W

- This building would be placed in cold standby.

Building 9720-19

- The rubber curing shop is located in this facility. This area would not be modified or its function altered.

Building 9204-2E

- This building would be modified to be used for lithium forming and machining. It would continue to function as the assembly facility, a testing (nondestructive testing) facility, and for storage.

No new facilities are required at Y-12 to support the secondary and case fabrication mission. Table A.3.2.1–1 summarizes key facility data, such as plant functions, nuclear materials present, building square footage, number of floors in the building, and type of construction.

Construction. Modification of Y-12 facilities to support the secondary and case fabrication mission would require 6 years to complete. The materials and resources that would be consumed during this period are summarized in table A.3.2.1–2. Emissions generated during construction are provided in table A.3.2.1–3. The principal sources of airborne emissions from construction are fugitive dust, construction activities, and exhaust from construction equipment and vehicles. Construction employment for the Y-12 Secondary and Case Fabrication Facility modification is shown in table A.3.2.1–4.

Operations. The secondary and case fabrication mission processes require the following utilities during operations: electricity, diesel fuel, natural gas, coal, air (compressed, dehumidified, and breathing), water (demineralized, fire, potable, plant, and cooling tower), and steam. Table A.3.2.1–5 presents the estimated utilities consumed during surge operation of the Y-12 secondary and case fabrication facilities. Chemicals consumed during secondary and case fabrication surge operations are summarized in table A.3.2.1–6.

Emissions. The contaminated and potentially contaminated zones within the plant facilities that handle uranium materials have high efficiency particulate air (HEPA) filtered ventilation systems that exhaust to the atmosphere. Some exhausts are provided with liquid scrubbing prior to HEPA filtration to remove chemical vapors such as nitric acid. The annual emissions for surge operation of the Y-12 secondary and case fabrication mission are shown in table A.3.2.1–7.

Employment. Y-12 generally operates with one shift per day, 5 days per week, except for some utility systems and security functions that operate continuously. Surge capacity would be accommodated by operating multiple shifts. The employment during surge operation for the secondary and case fabrication mission is summarized in table A.3.2.1–8. The data presented includes employees from the management and operating contractor, support organizations, and DOE.

Approximately 20 percent of the dosimeter badged population at Y-12 routinely work inside the radiological area (uranium handling areas). Based on current design definition, 20 percent is also assumed

TABLE A.3.2.1–1.—*Y-12 Plant Secondary and Case Fabrication Facility Data*

Building Number	Upgraded Uranium/Lithium Plant Function	Upgraded Uranium/Lithium Facility Usage (percent)	Nuclear Materials Present	Total Size (m^2)	Number of Floors	Type of Construction[a]
9103	Communication/support	10		6,780	3	B-1
9117	Communication/support	10		1,810	1	A-5
9119	Administration/support	100		6,660	4	B-5
9201-5N	Uranium/nonnuclear	85	Uranium	7,480	2	B-2
9204-2E	Uranium	85	Uranium	14,050	3	B-1
	Lithium	10	Lithium			
	Maintenance/support	5				
9212[b]	Uranium	40	Uranium	28,930	3	B-2
9215	Uranium	90	Uranium	14,590	3	B-2
	Nonnuclear	10				
9401-3	Steam plant support	10		3,130	3	B-4
9404-2	Compressed air/support	40		430	1	B-2
9706-2	Emergency Operations Center	20		2,040	2	A-2
	Medical/support	20				
9710-2	Fire station	10		1,760	1	B-2
9710-3	Security/support	60		3,820	4	B-3
9711-5	Cafeteria/support	10		5,360	2	B-1
9723-31	Changehouse/support	50		2,710	2	B-3
9995	Plant laboratory			7,810	2	B-3
	Uranium	6	Uranium			
	Lithium	3	Lithium			
	Nonnuclear	1				
9996	Uranium	100	Uranium	3,110	2	B-3
9998	Uranium	70	Uranium	12,740	2	B-3
	Nonnuclear	20				

[a] Building construction key:
Single story building with: A-1 wood frame, A-2 masonry bearing walls with wood roof framing, A-3 masonry bearing walls with structural steel roof stem, A-4 masonry bearing walls with precast concrete roof system, and A-5 prefabricated metal building with metal wall panels.
Multistory building with: B-1 reinforced concrete structure with masonry walls, B-2 reinforced concrete and structural steel with masonry walls, B-3 structural steel skeleton with

TABLE A.3.2.1–2.—*Y-12 Plant Secondary and Case Fabrication Construction Materials/Resources Requirements*

Material/Resource	Total Consumption	Peak Demand[a]
Concrete (m^3)	100	
Electricity (MWh)	2.7	0.2 MWe
Industrial gases[b] (m^3)	300	
Liquid petrochemicals (L)	10,000	
Steel (t)	20	
Water (L)	2,000,000	

[a] Peak demand is the maximum rate expected.
[b] Cubic meters measured at standard temperature and pressure.
Source: OR MMES 1996j; ORR 1995a:3; ORR 1995a:4.

TABLE A.3.2.1–3.—*Y-12 Plant Secondary and Case Fabrication Construction Emissions*

Pollutant	Quantity (t)
Carbon monoxide	2.4
Nitrogen oxides	0.8
Particulate matter	0.6
Sulfur dioxide	0.1
Total suspended particles	1.0
Volatile organic compounds	1.2

Source: OR MMES 1996j.

TABLE A.3.2.1–4.—*Y-12 Plant Secondary and Case Fabrication Construction Workers*

Employees	97	98	99	00	01	02	Total[a]
Craftworkers							
Carpenter	0.4	0.4	0.4	0.4	0.4	0	2
Concrete mason	0.2	0.2	0.2	0.2	0.2	0	1
Electrician	1	1	1	1	0.5	0,5	5
Iron worker	2	2	2	2	2	2	12
Laborer	1	1	2	1	1	1	7
Millwright		0.5	0.5	0.5	0.5		2
Operator	0.5	0.5	0.5	0.5	0.5	0.5	3
Other craftworkers	0.2	0.2	0.2	0.2	0.2		1
Pipe fitter	0.5	0.5	0.5	0.5	0.5	0.5	3
Sheet metal worker	0.4	0.4	0.4	0.4	0.4		2
Sprinkler fitter							0
Teamster	0.3	0.3	0.3	0.4	0.4	0.3	2
Total Craftworkers	6.5	7.0	8.0	7.1	6.6	4.8	40
Construction management and support staff	5.2	5.6	6.4	5.7	5.3	3.8	32
Total Employment	11.7	12.6	14.4	12.8	11.9	8.6	72

[a] Full-time equivalent.
Source: OR MMES 1996j; ORR 1995a:3; ORR 1995a:4.

TABLE A.3.2.1–5.—*Y-12 Plant Secondary and Case Fabrication Surge Operation Annual Utility Requirements*

Utility	Consumption	Peak Demand[a]
Coal (t)	500	
Diesel fuel (L)	250,000	
Electricity	118,000 MWh	19.0 MWe
Natural gas[b] (m^3)	17,000,000	
Raw water (L)	1,510,000,000	

[a] Peak demand is the maximum rate expected during any hour.

[b] Cubic meters measured at standard temperature and pressure.

Source: OR MMES 1996j; ORR 1995a:3; ORR 1995a:4.

TABLE A.3.2.1–6.—*Y-12 Plant Secondary and Case Fabrication Surge Operation Annual Chemical Requirements*

Chemical	Quantity (kg)
Solid Chemicals	
Aluminum trihydride	3,000
Barium nitrate	15
Borax	15
Calcium hydroxide	30,000
Calcium nitrate	150
Calcium oxide	150
Curing agent	4
Diatomaceous earth	2,500
Epoxy resin	10
Erbium oxide	75
Ferric sulfate	7,500
Graphite	2,000
Lithium carbonate	1,200
Magnesium sulfate	100
Methylene diphenyl diisocyanate	100
Nickel compounds	75
Polycure	75
Potassium carbonate	3,000
PVC plastisol	1,500
Silicon carbide	40
Sodium bicarbonate	75
Sodium carbonate	450
Sodium molybdate dihydrate	5
Sodium nitrate	1,500
Sodium potassium	3
Trisodium phosphate	250
Tungsten carbide	1
Yttria	150
Zirconium oxide	180
Liquid Chemicals	
Acetic acid	15
Acetone	8
Acetonitrile	150
Anisol	200
Corrosion inhibitor	800
Diamond paste	1
Diesel fuel	75,000
Ethanol	1,000
Gasoline	110,000
Hydraulic oil	3,000
Hydrogen peroxide	750
M-pyrol	50
Methanol	2,500
Micro/oakite detergent	12
Mineral oil	1,500
Mold release	7.5
Nitric acid	1,000
Nitrogen tetroxide	150
Oxalic acid	2
Petroleum oils (lubricants)	1,500
Potassium chloride	15
Propylene glycol	150
Pump oil	3
PVC primer	2
Solvent 140	750
Toluene 2,4-diisocyanate	100
1,1,1-Trichloroethane	800
Gaseous Chemicals	
Ammonia, anhydrous	7.5
Argon	1,400,000
Carbon dioxide	30,000
Chlorine	75
Freon or equal (cleaning)	750
Helium	6,000
Hydrogen	1,500
Nitrogen	5,000,000
Oxygen	50,000

Note: PVC- polyvinyl chloride.

Source: OR MMES 1996j; ORR 1995a:4.

TABLE A.3.2.1–7.—*Y-12 Plant Secondary and Case Fabrication Surge Operation Annual Emissions*

Pollutant	Quantity (t)
Carbon monoxide	7.4
Chlorine	0.15
Hydrogen chloride	4.8
Methyl alcohol	14
Nitric acid	7.1
Nitrogen oxides	195
Ozone	0.07
Particulate matter	0.5
Pressing lubricant	0.3
Sulfuric acid	1.8
Sulfur dioxide	80
Total suspended particles	10
Volatile organic compounds	1.2
Radiological Isotope	**Estimated Release**
Uranium-235 (microcuries)	420
Uranium-238 (microcuries)	1,490

Source: OR MMES 1996j; ORR 1995a:4.

for the Y-12 secondary and case fabrication mission. Therefore, it is estimated that 174 of the badged employees would be at risk of radiological exposure as shown in table A.3.2.1–8. In addition, on a nonroutine basis, a small fraction of badged visitors may enter the radiological area.

TABLE A.3.2.1–8.—*Y-12 Plant Secondary and Case Fabrication Surge Operation Workers*

Labor Category	Number of Employees	Risk of Radiological Exposure
Craftworkers	131	61
Laborers	8	—
Officials and managers	88	7
Office and clerical	95	—
Operatives	93	43
Professionals	284	35
Service workers	584	—
Technicians	93	28
Total Employees	1,376	174

Source: OR MMES 1996j; ORR 1995a:4.

Waste Management. The solid and liquid nonhazardous wastes generated during modification activities would include concrete and steel construction waste materials and sanitary wastewater. The steel waste would be recycled as scrap material before completing construction. The remaining nonhazardous wastes generated during construction would be disposed of by the construction contractor. Uncontaminated wastewater would be managed per site practice. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes would be packaged in DOT-approved containers and shipped offsite to commercial RCRA-permitted treatment, storage, and disposal facilities. A small amount of solid LLW consisting of contaminated steel and concrete would be generated. This waste would be placed in an appropriate container and shipped to an approved LLW disposal facility.

The project design considers and incorporates waste minimization and pollution prevention. Production processes would be configured with minimization of waste production given high priority. Future D&D considerations have also been incorporated into the design.

Table A.3.2.1–9 presents the estimated annual waste volumes from the secondary and case fabrication facilities during modifications and surge operations. Solid and liquid waste streams are routed to the waste management system. Figures A.3.2.1–3 through A.3.2.1–6 depict the waste management system. Solid wastes would be characterized and segregated into low-level, hazardous, and mixed wastes, then treated to a form suitable for disposal or storage within the facility. Liquid wastes would be treated onsite to reduce hazardous/toxic and radioactive elements before discharge or transport. All fire-sprinkler water discharged in process areas would be contained and treated as process wastewater, when required.

Spent Nuclear Fuel. The Secondary and Case Fabrication Facility would not generate any spent nuclear fuel.

Transuranic Waste. The Secondary and Case Fabrication Facility would not generate any TRU wastes.

TABLE A.3.2.1–9.—*Y-12 Plant Secondary and Case Fabrication Waste Volumes*

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations (m^3)	Annual Volume Effluent from Surge Operations (m^3)
Low-Level			
Liquid	None	320	None
Solid	8	1,120[a]	570[b]
Mixed Low-Level			
Liquid	None	3,400	3,400
Solid	1	92[c]	92
Hazardous			
Liquid	None	Included in mixed	Included in mixed
Solid	2	Included in mixed	Included in mixed
Nonhazardous (Sanitary)			
Liquid	27	320,000	319,400[d]
Solid	30[e]	13,500[f]	7,670[g]
Nonhazardous (Other)			
Liquid	Included in sanitary	Included in sanitary	Included in sanitary
Solid	2	10,000[h]	Included in sanitary

[a] Includes 10 m^3 of classified waste, 40 drums depleted uranium ash from chip oxidation (one 55 gal drum = 0.2 m^3), and 1,100 m^3 of unclassified waste.

[b] Assumes 100:1 wastewater to sludge ratio for the treatment of liquid LLW followed by 2:1 for solidification. Assumes 2/3 of LLW is compactible by a factor of 4:1. LLW in drums is not compactible.

[c] Includes 2 m^3 of classified waste and 90 m^3 of unclassified waste.

[d] Y-12 only pretreats industrial wastewater prior to discharge to the city of Oak Ridge Municipal Sanitary Sewer System.

[e] Includes 3.4 m^3 of concrete and 4.1 t of steel.

[f] Includes 5 m^3 of classified waste.

[g] Assumes 2/3 of solid is compactible by a factor of 4:1.

[h] Recyclable wastes.

Source: OR MMES 1996j; ORR 1995a:4.

Low-Level Waste. LLW would be generated by operation of the Secondary and Case Fabrication Facility and would consist primarily of depleted uranium oxide in drums and contaminated scrap metal, air filters, and HEPA filters. Approximately 10 percent of all LLW generated would currently be suitable for disposal onsite. The remaining waste would be packaged for offsite treatment and disposal at the waste feed preparation facility and stored at K-25, pending disposal at an approved disposal facility. Scrap metal would be sent offsite for smelting into shielding blocks for DOE use.

Mixed Low-Level Waste. Mixed LLW would be generated from operation of the Secondary and Case Fabrication Facility and would consist primarily of ash and sludge immobilized in grout, compacted gloves, and wipes. Mixed LLW would be collected in DOT-approved containers and sent to an onsite hazardous waste accumulation area. Waste suitable for incineration would be sent to the K-25 TSCA incinerator. After compaction, if appropriate, the remaining solid wastes would be packaged and stored onsite awaiting disposal by an offsite commercial vendor.

Hazardous Waste. These materials are included in the mixed LLW.

Nonhazardous (Sanitary) Waste. Sewage wastewater would be discharged directly to the Oak Ridge Municipal Wastewater Treatment System sewer system. Process wastewater would be treated in the sanitary wastewater treatment facilities and discharged through permitted NPDES outfalls. Sludge would be stored onsite, pending treatment by a com-

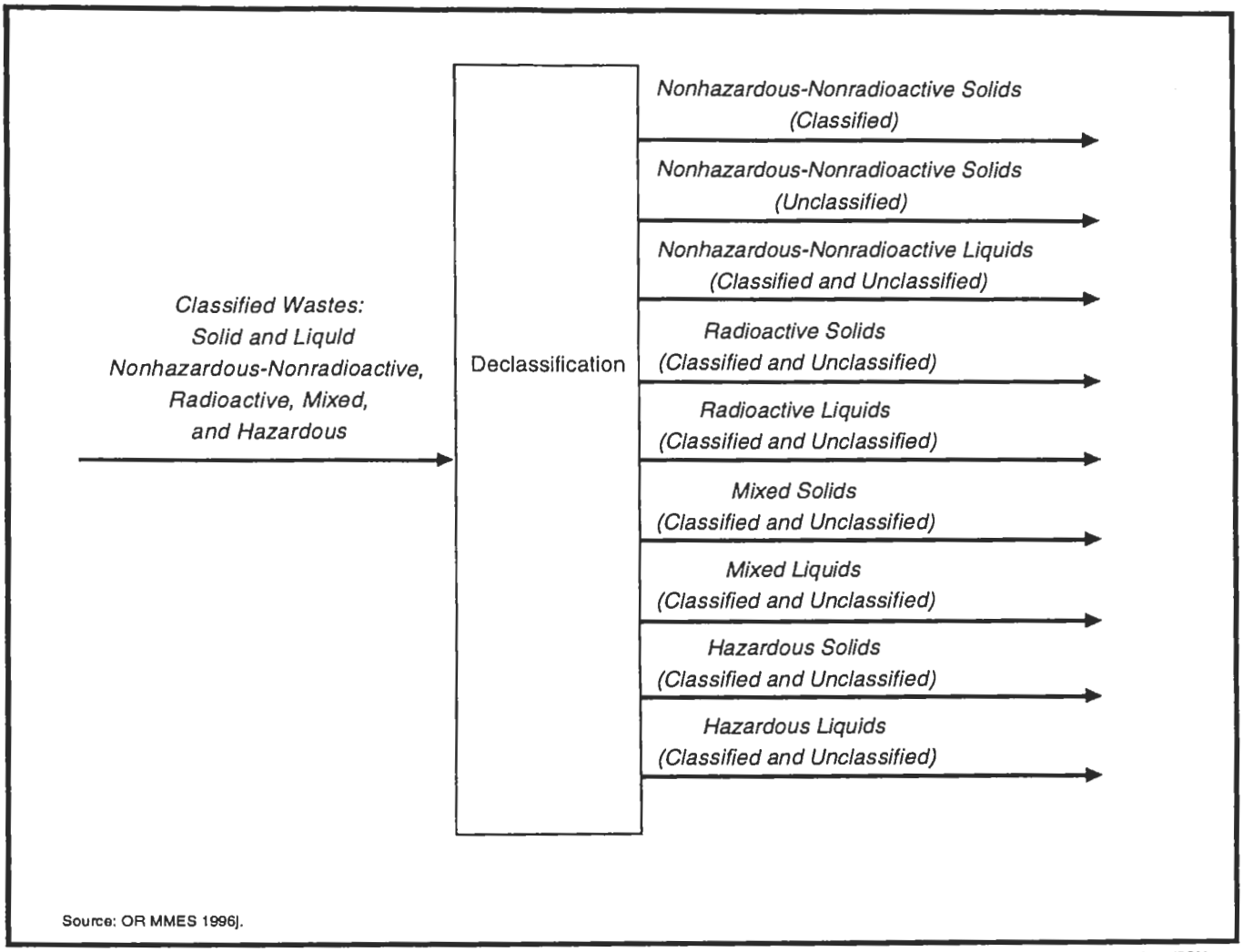


FIGURE A.3.2.1–3.—*Waste Management Process—Declassification.*

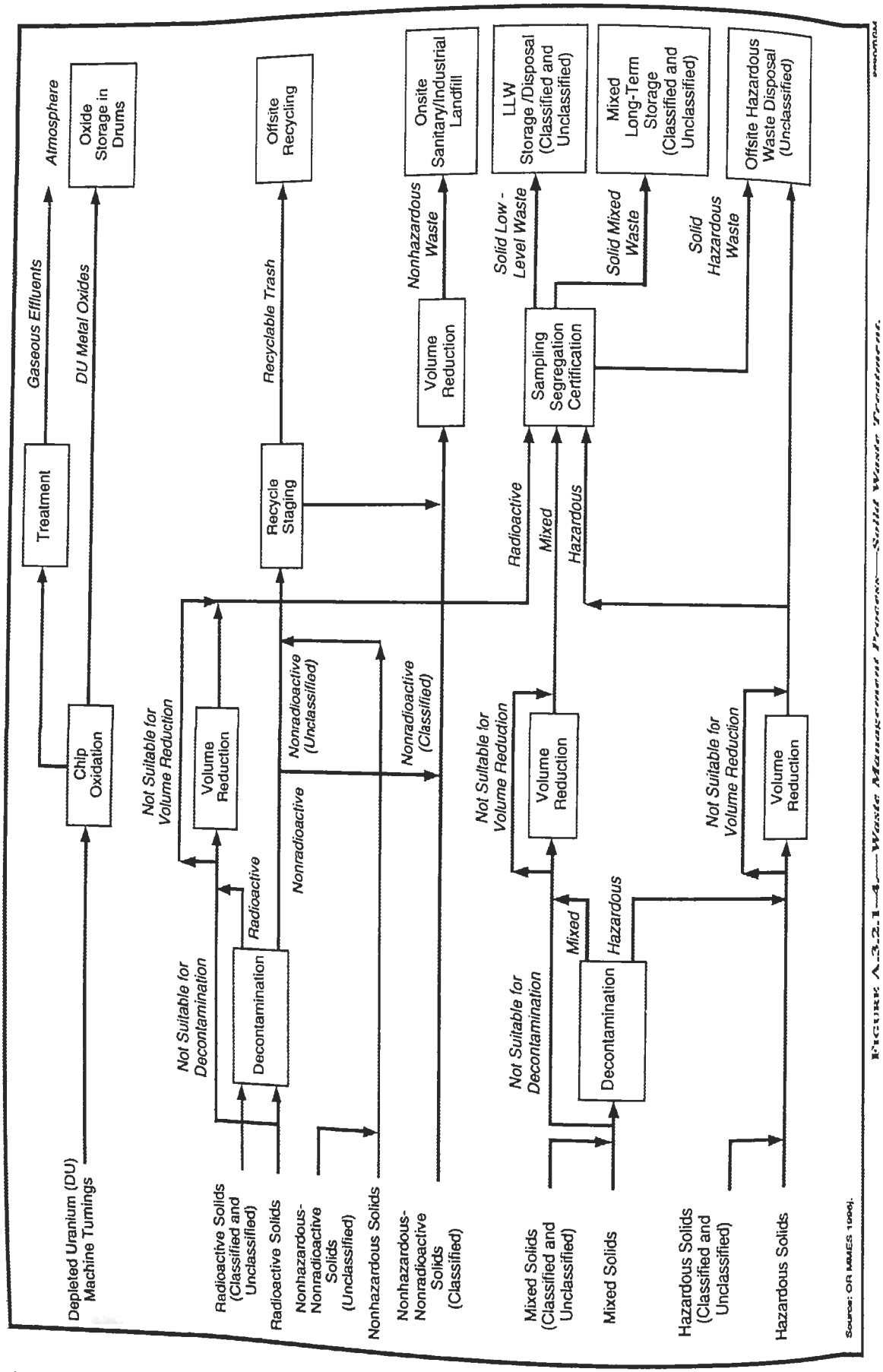


FIGURE A-3.2.1-4—Waste Management Process—Solid Waste Treatment.

Source: OR MAES 1994.

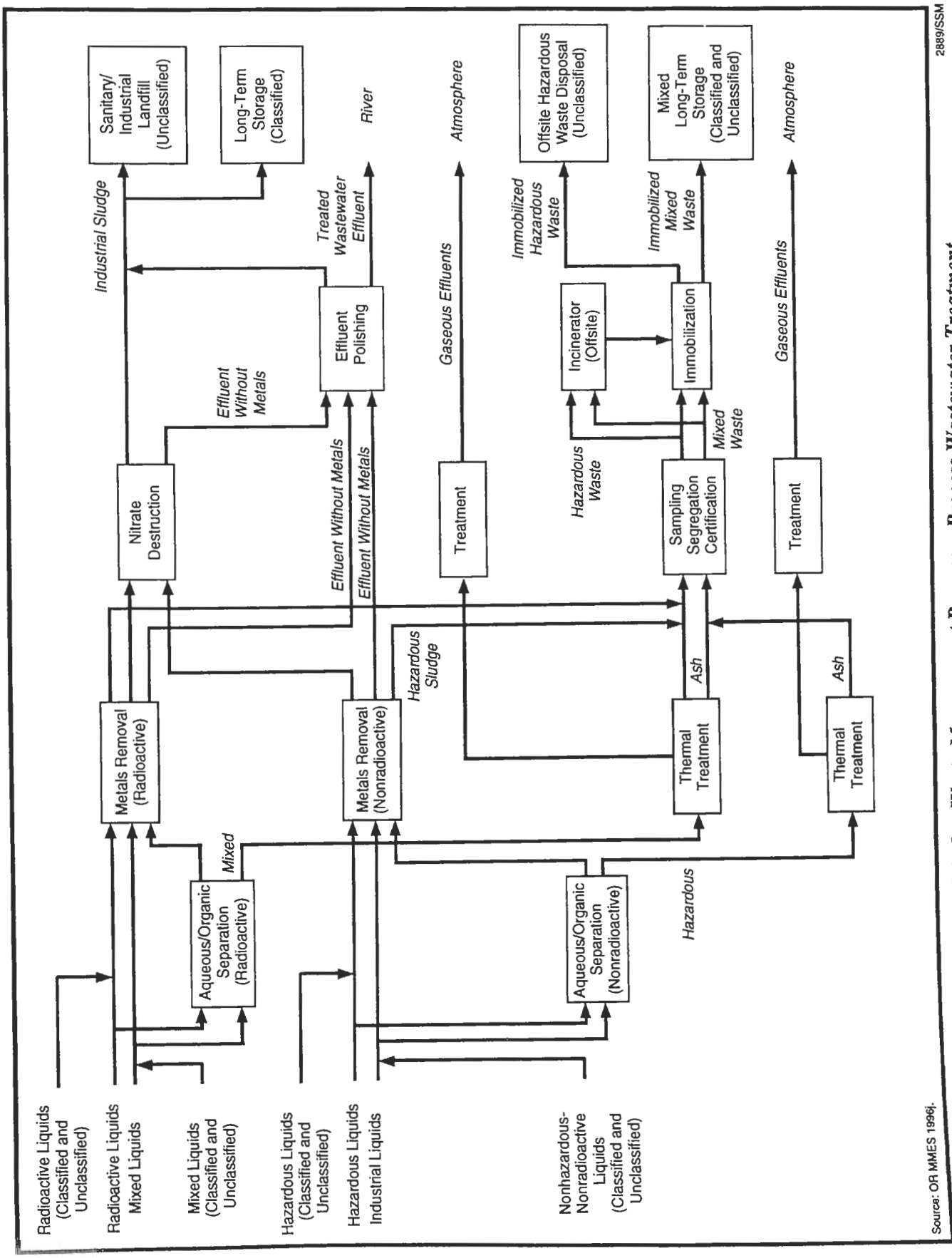
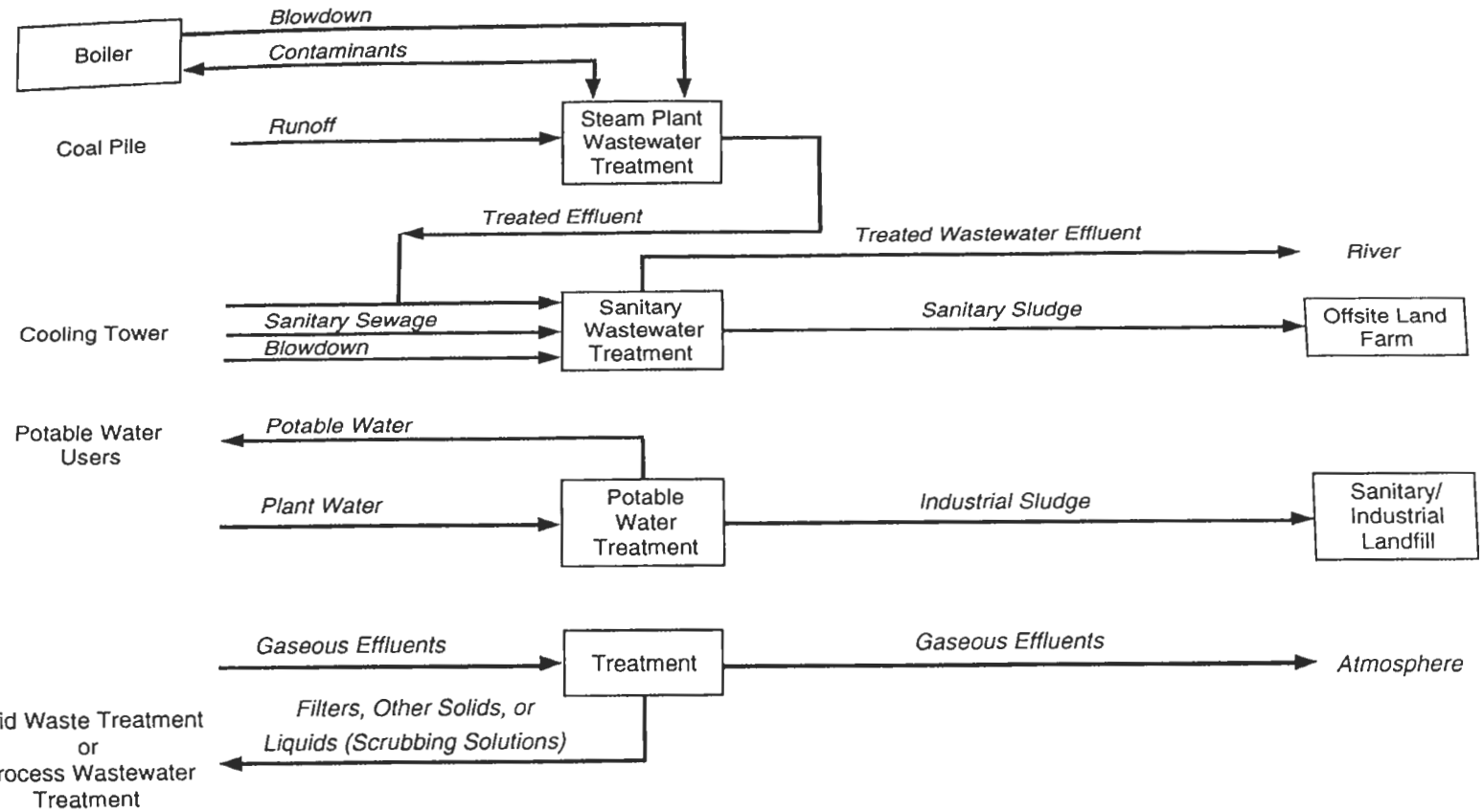


FIGURE A.3.2.1–5.—*Waste Management Process—Process Wastewater Treatment and Waste Thermal Treatment.*



Source: OR MMES 1996j.

mercial vendor. Nonhazardous solid wastes including small amounts of classified nonhazardous waste would be generated from operation of the Secondary and Case Fabrication Facility and disposed of in a State of Tennessee permitted Class II landfill.

Nonhazardous (Other) Waste. Nonrecyclable (other) wastes would be disposed of in a permitted landfill or discharged through permitted NPDES outfalls.

A.3.2.2 *Relocate to Los Alamos National Laboratory*

LANL secondary and case fabrication facilities would include all of the functional operations required to physically and chemically process, machine, inspect, assemble, certify, and disassemble secondary materials to produce canned subassemblies and radiation case components for the nuclear weapons physics package.

The secondary and case fabrication facilities would occupy 21,739 m^2 (234,000 ft^2) of floor space inside existing structures within their current footprint of 1.1 ha (2.7 acres). Additional land area for the construction of new buildings would not be required. A nominal area would be required for equipment staging, material laydown, and parking during the modifications of these facilities.

Facility Description. Secondary and case fabrication would utilize existing facilities within the boundaries of TAs -3, -8, -50, -54, and -55 (figure A.3.2.2–1). Facilities within each of these technical areas include the TA-3 Sigma Complex (SM-35, SM-66, and SM-141), the TA-3 Chemistry and Metallurgy Research building (SM-29), the TA-3 main machine shop (SM-39 and SM-102), the TA-8 Nondestructive Evaluation Facility (Buildings 22 and 23), the TA-55 Nuclear Material Storage Facility for overflow capacity, the TA-50 Liquid Radioactive Waste Treatment Facility, and the TA-54 Solid Radioactive Waste Treatment Area.

The flow of fissile material would be contained within the Chemistry and Metallurgy Research building (SM-29). Manufacturing operations would take their feeds from both incoming stockpile returns and the chemical recovery process. Components from manufacturing would be sent back out for assembly. Low-equity waste (graphite, booties, and machining fluids) would be sent back to waste management for processing, storage, and disposal. Recoverable quantities of fissile material would be reprocessed in chemical recovery and returned as feed stock to manufacturing.

Figure A.3.2.2–2 shows the major structures located in TA-3. The buildings shown on this plot plan for use in stockpile stewardship and management operations are SM-29, SM-35, SM-39, SM-66, SM-102, and SM-141. Modifications are required for the following facilities:

- Renovations to Chemistry and Metallurgy Research building Wings 2, 4, and 9
- SM-102 change room and ventilation upgrades
- SM-66-D103 lithium forming, machining, and inspection
- SM-35 lithium purification, salvage, and storage

Table A.3.2.2–1 summarizes key facility data for the building and support structures to be utilized in secondary and case fabrication.

The Chemistry and Metallurgy Research building is a large reinforced concrete building with a basement, a first floor, and an attic floor. This building has been classified as a Performance Category PC-3 Nuclear Facility (per DOE-STD-3009-94). The administration wing and Wing 1 contain second-floor office areas. The plan of the building is centered on a spinal corridor oriented in a north-south direction with an administration wing and seven laboratory wings (Wings 1, 2, 3, 4, 5, 7, and 9) that extend from the corridor. Wings 2, 3, 4, 5, and 7 have equipment/change rooms located at the front of each wing and filter towers located at the end of the wings, which house the filter plenum and other large mechanical equipment for the exhaust ventilation system. The building also contains a waste assay facility located at the loading dock between Wings 1 and 4 and a Category I special nuclear material vault. The Chemistry and Metallurgy Research building replaced the World War II "D" building and was designed to house analytical chemistry facilities, plutonium metallurgy, uranium chemistry, engineering design and drafting, electronics, and other

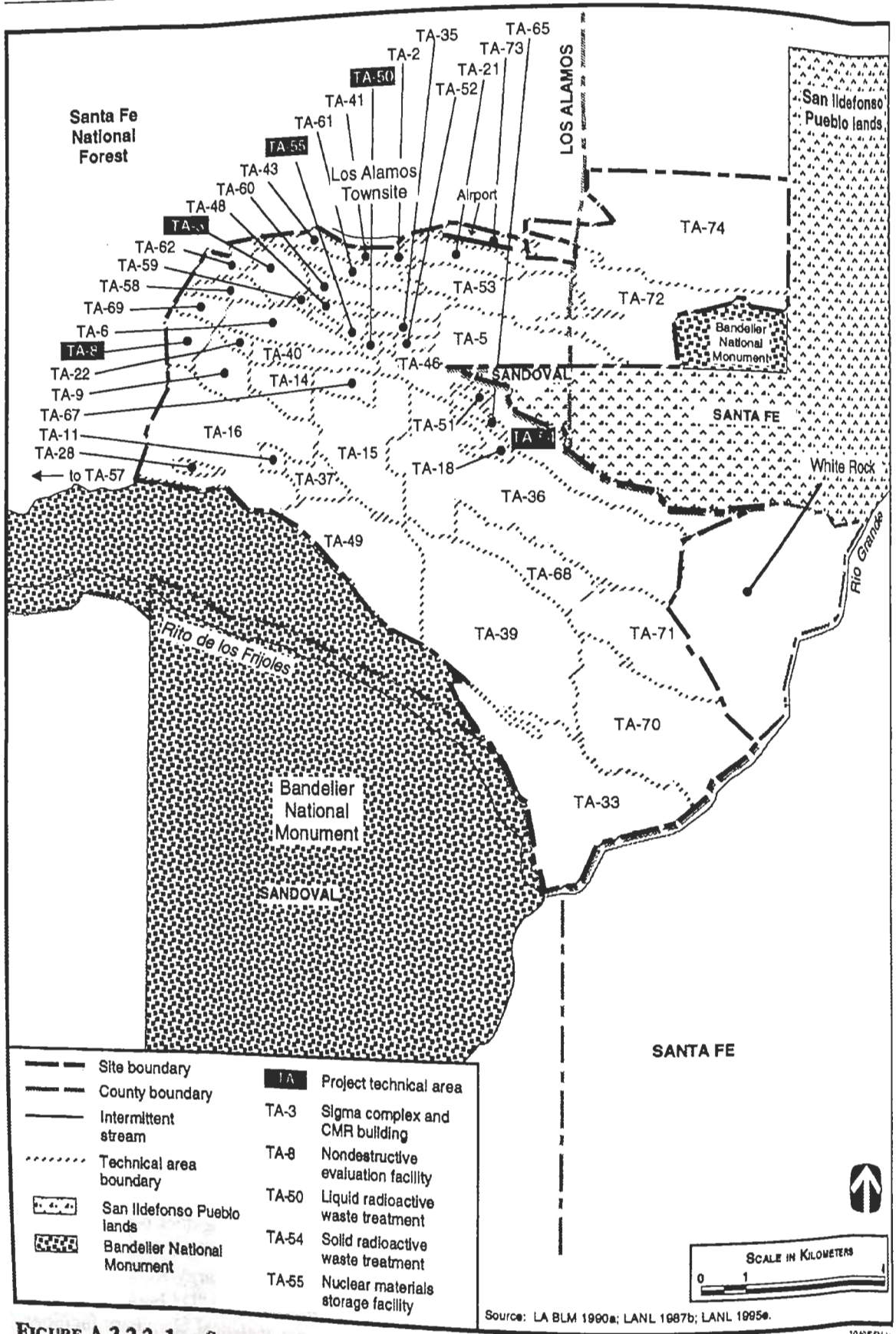


FIGURE A.3.2.2–1.—*Secondary and Case Fabrication Alternative Technical Areas at Los Alamos National Laboratory.*

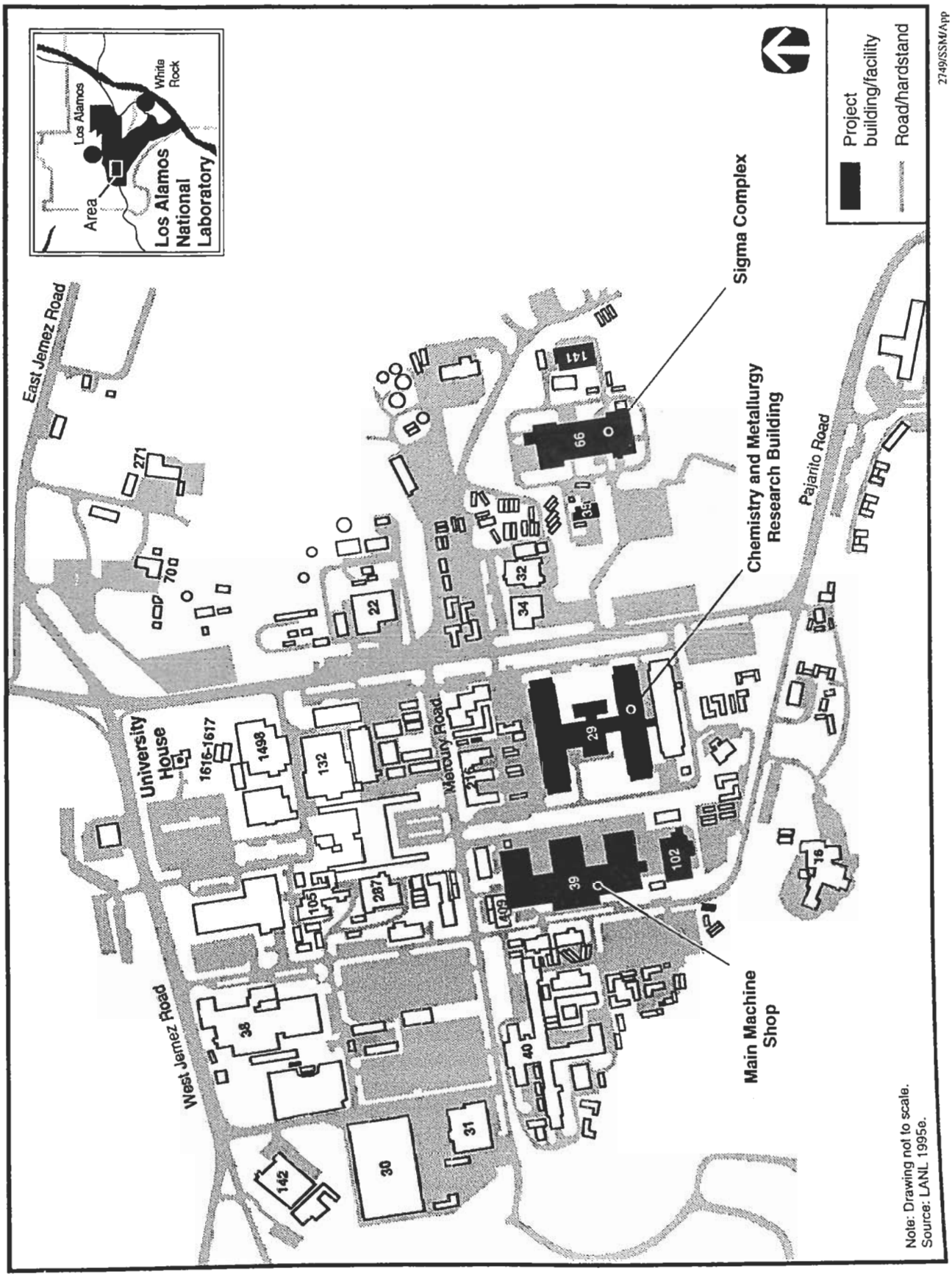


FIGURE A.3.2.2–2.—*Secondary and Case Fabrication Alternative Facilities at Los Alamos National Laboratory Technical Area 3.*

TABLE A.3.2.2–1.—*Los Alamos National Laboratory Secondary and Case Fabrication Facility Data*

Building	Footprint (m^2)	Number of Levels	Special Materials	Construction Type
SM-29 Chemistry and Metallurgy Research	51,097	3	Special nuclear materials	Concrete post and beam with concrete masonry unit in-fill walls
SM-66 Sigma	15,794	3	NA	Concrete post and beam with concrete masonry unit in-fill walls
SM-39 Nonnuclear Shops	14,202	3	NA	Concrete post and beam with concrete masonry unit in-fill walls
SM-102 Uranium Shops	2,090	3	NA	Concrete post and beam with concrete masonry unit in-fill walls
SM-141 Rolling Mill	1,858	2	NA	Concrete post and beam with concrete masonry unit in-fill walls
SM-35 Press	929	2	NA	Concrete foundation with steel pillars and sheet metal walls
SM-67 Guard Station Sigma	22.9			
SM-127 Cooling Tower	138			
SM-145 Switchgear Station	39			
SM-147 Air Plenum and Fan	15.2			
SM-154 Chemistry and Metallurgy Research Cooling Tower	37.2			
SM-159 Forming	14.9			
SM-161 Magazine	1.5			
SM-169 Warehouse	581			
SM-187 Cooling Tower	37.2			
SM-317 Graphite Flour Storage	140.5			
SM-451 Micro Machining	160			
TA-8-22 Nondestructive Evaluation Lab	843			
TA-8-23 Nondestructive Evaluation Support	316			

Note: NA - not applicable.
Source: LANL 1995e.

support functions. At the time it was built, the Chemistry and Metallurgy Research building represented the state-of-the-art instrumentation and safety controls for a modern chemistry laboratory.

The Sigma Complex comprises three main processing buildings located in TA-3 just east of the Chemistry and Metallurgy Research building. The fenced area encompassing the Sigma Facility contains a total of 16 buildings. The three buildings designated as SM-66, SM-141, and SM-35 contain the majority of laboratory space. Other structures house utilities, support functions, and storage areas. The Sigma Complex has been classified as a low-hazard chemical (PC-1), nonnuclear facility.

The Press building (SM-35) is the oldest building i this complex. Construction was completed in 195 The building was originally designed to house th 4,536-t (5,000-ton) press for the Materials Technol ogy Group. Building construction consists of a concrete foundation and supporting steel pillars wit insulated double sheet metal walls outside. Inside walls (separating various work areas and offices) ar similar or made of concrete block.

The Rolling Mill building (SM-141) has reinforce concrete foundations, floors, support columns, an beams with concrete block exterior walls. Interio walls separating various work areas and offices ar made of concrete block and/or metal studs wit

gypsum board. The roof is built of tar and gravel over rigid insulation and is supported by steel joists. The building was designed to house areas for powder metallurgy and fabrication. Today the Rolling Mill building continues to house these activities in addition to work areas for ceramics research, beryllium technology, and development and rapid solidification research.

The Sigma building (SM-66) was constructed in 1959 and was originally designed to house activities in physical metallurgy, ceramics, powder metallurgy, plastics, a metal foundry, electrochemistry, fabrication, and other support functions. Today the Sigma building continues to house all these functions except plastics. The building is built on a reinforced concrete foundation using reinforced concrete post and beam construction techniques. The exterior walls are constructed of concrete block fill between the supporting posts and beams. The mezzanine spaces are constructed of supported metal decking. Interior walls separating various work areas and offices are also concrete block or metal studs and gypsum board. The roof is built of tar and gravel over rigid insulation and metal decking supported by steel joists. The building has a basement, a first floor, and a small second floor. The plan of the building is on a spinal corridor oriented in a north-south direction. SM–66 has 11 major work areas that extend from the corridor.

Building SM-102 is connected to the Main Shops building, SM-39, by a 38-m (125-ft) long corridor. Constructed in the late 1950s, it originally housed a foundry, a heat-treating operation, a graphite machining shop, and a radioactive materials machine shop. Since that time, the northeast corner of the building, which provided programmatic support to the Rover Project, has been decommissioned and now is dedicated to the support of Engineering, Sciences, and Applications division operations. Currently, the southern half of the building is occupied primarily by Shop 13, the uranium and lithium machine shops. The building is constructed of cinder block and has a concrete floor. Shop 13 contains machines that are used for machining operations on uranium. The majority of the building houses pyrophoric, toxic, and radioactive material machining and a dimensional inspection area. SM-102 has been classified as a low-hazard chemical (PC-1), nonnuclear facility.

Building SM-39 is of concrete and cinder block construction. The main bay is aligned from north to south and is 183 m (600 ft) in length by 37 m (120 ft) in width. Three wings extend eastward from the north and south ends of the bay, as well as the middle of the main bay. The south main (high) bay section, the middle wing, and the south wing contain metal and machining shops owned by the Mechanical Fabrication Group. SM-39 has been classified as a low-hazard chemical (PC-1), nonnuclear facility.

The north wing contains offices occupied by the Materials Technology Polymers & Coatings Group (MST-7) and the Standard and Calibration Group (ESH-9). It also contains Mechanical Fabrication Group beryllium machining and inspection, a glass shop operated by MST-7, and a Standards and Calibration Laboratory operated by ESH-9. Three transportable equipment storage trailers are located on the south side of the north wing.

Construction. Modification to the LANL facilities to perform the stockpile management secondary and case fabrication mission would require approximately 7 years for design, construction, mission transfer, and operational startup. With conceptual design beginning in 1997, operational startup could commence in 2004. The materials and resources consumed during modification activities are provided in table A.3.2.2–2.

Emissions generated during modification activities are provided in table A.3.2.2–3. The principal sources of airborne emissions during modification are fugitive dust, construction debris, and exhaust from construction equipment and vehicles.

TABLE A.3.2.2–2.—*Los Alamos National Laboratory Secondary and Case Fabrication Construction Materials/Resources Requirements*

Material/Resource	Total Consumption	Peak Demand[a]
Concrete (m^3)	245	
Electricity	4,130 MWh	0.75 MWe
Industrial gases[b] (m^3)	11,500	
Liquid fuel (L)	22,700	
Steel (t)	54	
Water (L)	4,160,000	

[a] Peak demand is the maximum rate expected.

[b] Cubic meters measured at standard temperature and pressure.

Source: LANL 1995b:4; LANL 1995e.

TABLE A.3.2.2–3.—*Los Alamos National Laboratory Secondary and Case Fabrication Construction Emissions*

Pollutant	Quantity (t)
Carbon monoxide	<1[a]
Lead	0
Nitrogen dioxide	<1[a]
Particulate matter	<1[a]
Sulfur dioxide	<1[a]
Volatile organic compounds	0

[a] The total of all criteria pollutants is estimated to be less than 1 metric ton.

Source: LANL 1995b:4; LANL 1995e.

Employment needs during the modification phase are presented in table A.3.2.2–4.

Operation. The secondary and case fabrication processes require the following utilities during operation: electricity, natural gas, diesel fuel, air, water, and steam. Table A.3.2.2–5 presents a listing of the utilities consumed during Secondary and Case Fabrication Facility surge operations. Chemicals consumed during operation are summarized in table A.3.2.2–6.

The annual emissions from surge operation required in the Secondary and Case Fabrication Facility are based on historical emissions and amounts of materials to be processed as shown in table A.3.2.2–7.

Employment. The employment needs in support of secondary and case fabrication surge operation activities at LANL are summarized in table A.3.2.2–8.

TABLE A.3.2.2–4.—*Los Alamos National Laboratory Secondary and Case Fabrication Construction Workers by Year*

Labor Category	Year 1	Year 2	Year 3	Year 4	Total
Total craftworkers	34	45	45	45	169
Construction management and support staff	6	10	10	10	36
Total Employment	40	55	55	55	205

Source: LANL 1995e.

TABLE A.3.2.2–5.—*Los Alamos National Laboratory Secondary and Case Fabrication Surge Operation Annual Utility Requirements*

Utility	Consumption	Peak Demand[a]
Diesel fuel (L)	100,000	
Electricity	36,000 MWh	5 MWe
Natural gas[b] (m^3)	0	
Water (L)	55,000,000	

[a] Peak demand is the maximum rate expected during any hour.

[b] Cubic meters measured at standard temperature and pressure.

Source: LANL 1995b:4; LANL 1995e.

TABLE A.3.2.2–6.—*Los Alamos National Laboratory Secondary and Case Fabrication Surge Operation Annual Chemical Requirements* [Page 1 of 2]

Chemical	Quantity (kg)
Solid Chemicals	
Aluminum nitrate	75
Aluminum trihydride	3,000
Barium nitrate	15
Borax	15
Calcium hydroxide	30,000
Calcium nitrate	150
Curing agent	4
Epoxy resin	10
Ferric sulfate	7,500
Graphite	2,000
Lithium chloride	6,000
Magnesium sulfate	100
Methylene diphenyl diisocyanate	100
Nickel compounds	75
Polycure	7
Potassium carbonate	3,00
PVC plastisol	1,50
Silicon carbide	4
Sodium bicarbonate	7
Sodium carbonate	45
Sodium molybdate dihydrate	
Sodium nitrate	1,5
Trisodium phosphate	2
Tungsten carbide	
Yttria	3

TABLE A.3.2.2–6.—*Los Alamos National Laboratory Secondary and Case Fabrication Surge Operation Annual Chemical Requirements* [Page 2 of 2]

Chemical	Quantity (kg)
Liquid Chemicals	
Acetic acid	15
Acetone	20
Acetonitrile	150
Anisol	200
Corrosion inhibitor	800
Diamond paste	1
Dibutyl carbitol	1,000
Ethanol	1,000
Gasoline and diesel	100,000
Hydraulic oil	3,000
Hydrogen peroxide	750
Kerosene, high grade	150
M-pyrol	50
Methanol	2,500
Micro/oakite detergent	12
Mineral oil	1,500
Mold release	7.5
Nitric acid	1,000
Nitrogen tetroxide	150
Oxalic acid	2
Petroleum oils (lubricants)	1,500
Potassium chloride	15
Propylene glycol	150
Pump oil	3
PVC primer	2
Solvent 140	750
Toluene 2,4 diisocyanate	100
Gaseous Chemicals	
Ammonia, anhydrous	7.5
Argon	1,000,000
Carbon dioxide	10,000
Chlorine	75
Freon or equal (cleaning)	750
Helium	6,000
Hydrogen	1,500
Nitrogen	500,000
Oxygen	50,000

Note: PVC- polyvinyl chloride.
Source: LANL 1995b:4; LANL 1996e:1.

TABLE A.3.2.2–7.—*Los Alamos National Laboratory Secondary and Case Fabrication Surge Operation Annual Emissions*

Pollutant	Quantity (t)
Carbon monoxide	4.5
Lead	0.1
Nitrogen dioxide	117
Particulate matter	0.3
Sulfur dioxide	48
Volatile organic compounds	0.6
Radiological Isotope	**Estimated Release**
Uranium 235 (microcuries)	486
Uranium 238 (microcuries)	1776

Source: LANL 1995b:4.

TABLE A.3.2.2–8.—*Los Alamos National Laboratory Secondary and Case Fabrication Surge Operation Workers*

Labor Category	Number of Employees	Employees at Risk of Radiological Exposure
Office and clerical	26	0
Officials and managers	34	4
Professionals	37	13
Service workers	244	61
Technicians	182	73
Total Employees	523[a]	151

[a] Total surge employment. Increment to current employment would be 321.
Source: LANL 1995b:4.

Nearly all of the personnel performing operations in the secondary fabrication facilities would be dosimeter-badged. As shown in table A.3.2.2–8, it is estimated that approximately 151 workers would be at risk of radiological exposure. In addition, a small fraction of badged visitors may nonroutinely enter radiological areas.

Waste Management. Wastes generated during secondary and case fabrication operations include radioactive, mixed, hazardous, and nonhazardous byproducts. Secondary and case fabrication operations would not generate any high-level or TRU

wastes. Low-level radioactive waste would consist primarily of depleted uranium oxide chips, contaminated scrap metal, and filter media. Mixed and hazardous wastes would consist of ash, sludges, filters, rags, and wipes. Liquid radioactive and inorganic chemical wastes that meet the LANL waste acceptance criteria are sent either by truck or industrial drain to be processed at TA-50, Building 1. Mixed wastes are currently stored at TA-54; liquids in Area L and solids in Area G. Hazardous and organic chemical (RCRA) wastes are packaged and shipped to TA-54, Area G, for interim storage and subsequently shipped offsite. Nonhazardous solid waste is collected in dumpsters and taken to the landfill operated by Los Alamos County. Sanitary liquids are disposed of by either sanitary drain or permitted outfall. Sanitary process and support liquids are sent by drain to the sanitary wastewater treatment plant, TA-46, and treated similarly to municipal sewage. Table A.3.2.2–9 provides an estimate of the annual quantities of these waste categories for Secondary and Case Fabrication Facility surge operation.

A.3.2.3 *Relocate to Lawrence Livermore National Laboratory*

The LLNL secondary and case fabrication facilities would be housed within existing buildings at the Livermore Site (figure A.3.2.3–1). All of the structures required to house the secondary and case fabrication functions are in place; finalizing the capability would require installing some new equipment, moving existing equipment to other locations, and modifying some facilities to meet production requirements. A new structure, a 167-m^2 (1800-ft^2) steel framed, Butler-type building would be required to provide covered space within the Superblock protected area in which to house the enriched uranium inventory. At the Livermore Site, the existing security system for the fenced Superblock could be used with minor modifications to include

TABLE A.3.2.2–9.—*Los Alamos National Laboratory Secondary and Case Fabrication Waste Volumes*

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations (m^3)	Annual Volume Effluent from Surge Operations (m^3)
Low-Level			
Liquid	None	192	None
Solid	134	690	349[a]
Mixed Low-Level			
Liquid	None	30	30
Solid	10	108	108
Hazardous			
Liquid	None	60	60
Solid	37	216	216
Nonhazardous (Sanitary)			
Liquid	890	20,240	20,370
Solid	120	1,160	639[b]
Nonhazardous (Other)			
Liquid	Included in sanitary	None	None
Solid	10[c]	3,000	3,000

[a] Assumes 2/3 of the solid LLW is compactible by a factor of 4:1. The wastewater to sludge ratio for liquid LLW treatment is 100:1, followed by 2:1 solidification ratio.

[b] Assumes 2/3 of the solid waste is compactible by a factor of 4:1. The wastewater to sludge ratio for liquid sanitary treatment is 350:1.

[c] Includes 300 t of recyclable steel and 18 t of recyclable copper.

Source: LANL 1995b:4; LANL 1995e.

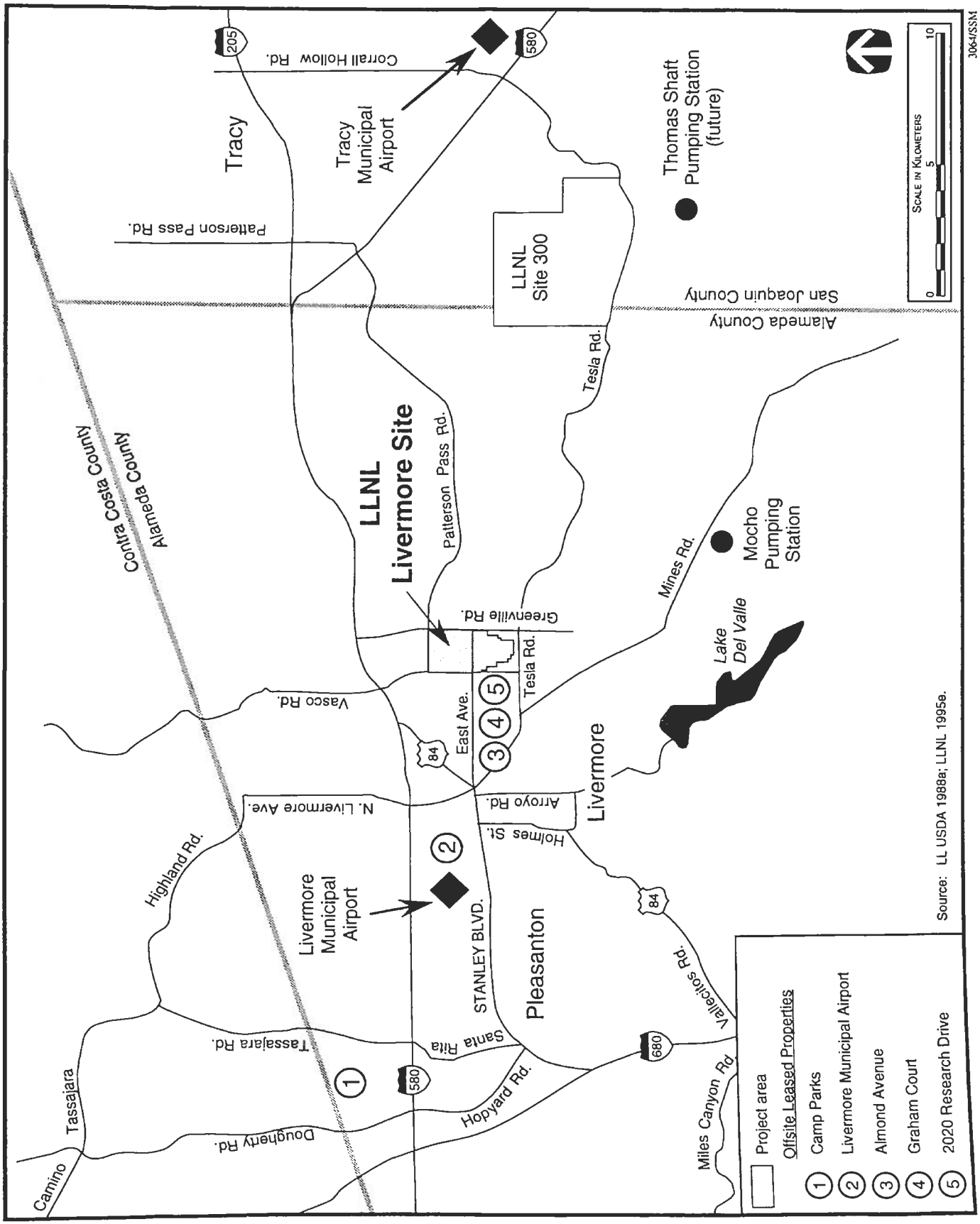


FIGURE A.3.2.3–1.—*Secondary and Case Fabrication Area at Lawrence Livermore National Laboratory.*

Building 239, the radiographic facility for enriched uranium fabrication, assembly, disassembly, storage, and surveillance operations.

Manufacturing and assembly of the canned secondary assemblies would take place in the buildings indicated on the Livermore Site plan, figure A.3.2.3–2. The overall site occupies approximately 332 ha (821 acres) and is surrounded by security fencing. The individual facilities to be used for secondary and case fabrication are within protected areas, limited areas, or exclusion areas as required for security and safeguards. Support facilities are located both inside and outside the security areas but inside the overall site perimeter fence, which is controlled at the entrances to the perimeter fenced area. The required facilities comprise approximately 19,500 m^2 (210,000 ft^2) and cover approximately 2 ha (5 acres). The Livermore Site has sufficient yard area and warehousing space to accommodate required laydown areas for receipt and staging of equipment and construction materials. In addition, parking for construction workers is available onsite.

Facility Description. Uranium parts are fabricated within a high-security, fenced area of the Livermore Site Superblock. Building 332 would house casting, machining, chemical recovery, destructive testing, nondestructive testing, dimensional inspection, storage, and A/D/surveillance operations. LLNL would use Building 334 as an additional site for A/D/surveillance operations and for metalworking of uranium parts.

The uranium processing facility is divided into three heating ventilation and air conditioning zones for radioactive contamination confinement. Zone 1 comprises areas where radioactive materials are handled and processed and includes enriched uranium receiving, processing, and storage areas. Zone 2 consists of areas where there is normally no radioactive contamination, but where there is the possibility of contamination. This zone includes the rooms containing glove boxes, process operating areas, and service corridors surrounding Zone 1 areas. Building 332 is a reinforced-concrete structure meeting the requirements of DOE 430.1, *Life-Cycle Asset Management*. The existing fire protection; radiation monitoring; heating, ventilation, and air conditioning; and emergency power facilities in Building 332 would be used. Building 239 would be used for radiography. Other buildings used in enriched uranium operations would include Building 177 for mass spectroscopy and Buildings 222, 235, and 251. These buildings are existing facilities that are adequate for this mission, and only minor modifications and upgrades would be needed.

As in the uranium parts manufacture, Building 239 is used for radiography, Building 177 for mass spectroscopy, and Buildings 222 and 251 for chemical laboratory analysis. The existing facilities in Building 235 are used for chemical laboratory analysis and nondestructive testing. Additional nondestructive testing functions take place in Building 327. Building 322 is used for some uranium part plating operations. The existing facilities in Buildings 322 and 327 are adequate for this mission. All of these facilities have been reviewed and approved for adequacy of building construction in accordance with applicable design codes and standards for the planned mission to be performed.

The special materials fabrication operations are performed in Buildings 231 and 241. Mass spectroscopy will be done in the existing facilities in Building 177, and chemical laboratory analysis in Buildings 222 and 235. Dimensional inspection is done in Building 321. Special materials would be fabricated in existing facilities in Building 231, with finishing operations to take place in Building 241. Again, all of these facilities have been reviewed and, with the exception of Building 241, approved for adequacy of building construction in accordance with applicable design codes and standards for the planned mission to be performed. Building 241 would require some minor, additional seismic retrofits before operations could commence.

The nonnuclear component fabrication capabilities would be housed in the extended Building 321 area complex at the Livermore Site. This includes the major Buildings 321 (with Wings A, B, C), 327, 329, and 322. Mechanical specimen testing would be performed in Building 231.

Table A.3.2.3–1 summarizes key facility data for the buildings and support structure to be utilized in secondary and case fabrication. While table A.3.2.3–1 summarizes all the facilities that are proposed for the canned secondary assemblies mission at LLNL, many of the facilities are used only for sample tests and are existing facilities that would

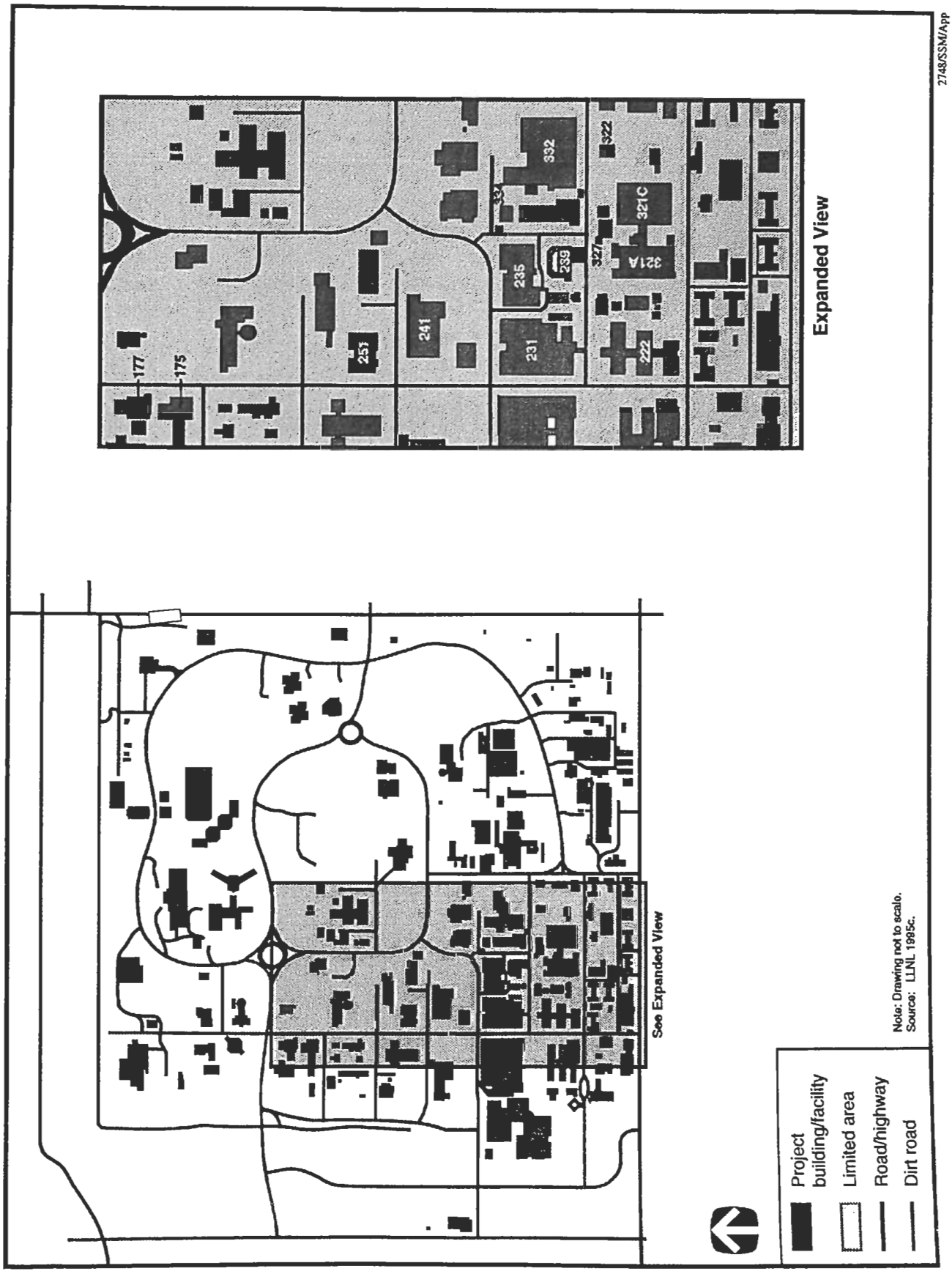


FIGURE A.3.2.3-2.—*Secondary and Case Fabrication Site Plan at Lawrence Livermore National Laboratory.*

TABLE A.3.2.3–1.—*Lawrence Livermore National Laboratory Secondary and Case Fabrication Facility Data*

Building Name	Footprint (m^2)	Number of Levels	Special Materials	Construction Type
B-175	734	1	None	Reinforced concrete
B-177	28	1	SNM	Steel frame
B-222	113	1	SNM	Steel frame
B-231	1,661	1	None	Steel frame
B-235	140	2	SNM	Steel frame
B-239, Radiography	136	2 + basement	SNM	Reinforced concrete
B-241	620	1	None	Steel frame
B-251	19	1	SNM	Steel frame
B-321	13,945	2	None	Steel frame
B-322	149	1	None	Steel frame
B-327	143	1	None	Steel frame
B-329	484	1	None	Steel frame
B-332	738	2	SNM	Reinforced concrete
B-334	438	3	SNM	Reinforced concrete
New, Butler storage building	167	1	SNM	Steel frame

Note: SNM - special nuclear materials.
Source: LLNL 1995e.

be used as is and shared with other LLNL programs. Buildings 177, 222, 235, 251, 322, 327, and 329 fit into this category. The remaining facilities are discussed because they are the main processing facilities for the canned secondary assemblies mission.

Construction. Modification to the Livermore Site facilities, as discussed above, to perform the secondary and case fabrication mission would require approximately 3 years based on a fiscal year 1998 start date, with the first production unit scheduled for the beginning of 2004. To meet this milestone, facilities would have to be in place several years before that date to provide for certification of equipment and processes and for training and certification of personnel. It is anticipated that facilities would be required to be in place for this activity no later than 2001.

The materials and resources consumed during the modification phase are provided in table A.3.2.3–2. Information is based on a 3-year construction schedule.

TABLE A.3.2.3–2.—*Lawrence Livermore National Laboratory Secondary and Case Fabrication Construction Materials/Resource Requirements*

Material/ Resource	Total Consumption	Peak Demand
Concrete (m^3)	612	
Electricity	3,500 MWh	400 kW
Gasoline, diesel fuel, and lube oil (L)	908,000	
Industrial gases[b] (m^3)	142	
Steel (t)	73	
Water (L)	8,710,000	

[a] Peak demand is the maximum rate expected.
[b] Cubic meters measured at standard temperature and pressure.
Source: LLNL 1995e.

Estimated emissions generated during modifi activities for the secondary and case fabri mission at LLNL are provided in table A.3.2.3–

TABLE A.3.2.3–3.—*Lawrence Livermore National Laboratory Secondary and Case Fabrication Construction Emissions*

Pollutant	Quantity (t)
Carbon monoxide	635
Oxides of nitrogen	63.5
Particulate matter	544
Sulfur dioxide	5.44
Volatile organic compound	6.53

Source: LLNL 1995e.

principal sources of airborne emissions during facility modification would be fugitive dust, construction debris, and exhaust from construction equipment and vehicles. The peak year is defined as the year when modification activities would be the highest and equipment is anticipated to be arriving for installation.

Employment needs during the modification period are presented in table A.3.2.3–4. The modification activities would include some site work on the secondary fence enclosure of Building 239; seismic upgrades to Buildings 231 and 242; upgrades to building utilities such as electrical distribution systems, heating, ventilation and air conditioning, and security systems; and installation and checkout of equipment.

TABLE A.3.2.3–4.—*Lawrence Livermore National Laboratory Secondary and Case Fabrication Construction Workers*

Employees	Year 1	Year 2	Year 3	Total
Construction management and support staff	15	15	10	40
Craftworkers	115	115	60	290
Total Employment	130	130	70	330

Source: LLNL 1995e.

During modification activities, some support personnel and crafts would be at risk of radiological exposure. Approximately 20 personnel involved in decontamination of the 5 rooms in Building 332 would be at risk during the first year of construction. However, since the building is a certified plutonium handling facility, all construction personnel working in this building during the modification phase would be at some risk of radiological exposure.

Operations. The secondary and case fabrication processes would require consumable materials and resources to maintain facility operations. Annual utility consumption for surge operations secondary and case fabrication at the Livermore Site is presented in table A.3.2.3–5.

TABLE A.3.2.3–5.—*Lawrence Livermore National Laboratory Secondary and Case Fabrication Surge Operation Annual Utility Requirements*

Utility	Consumption	Peak Demand[a]
Electricity	15,000 MWh	2 MWe
Liquid fuel (L)	85,200	
Natural gas[b] (m^3)	566,000	
Raw water (L)	194,000,000	

[a] Peak demand is the maximum rate expected during any hour.
[b] Cubic meters measured at standard temperature and pressure.

Source: LLNL 1995e; LLNL 1995i:3; LLNL 1996i:2.

Table A.3.2.3–6 lists the estimated annual chemicals consumed during surge operation of the secondary and case fabrication mission at LLNL.

The estimated annual emissions from surge operation of the Secondary and Case Fabrication Facility are based on historical emissions and amounts of materials to be processed and are shown in table A.3.2.3–7.

Employment. The additional employment needs in support of secondary fabrication surge activities at LLNL are summarized in table A.3.2.3–8.

Approximately 250 (33 percent) badged employees would work inside radiological areas and are considered to be at risk for radiological exposure. In addition, a small fraction of badged visitors may nonroutinely enter radiological areas. Table A.3.2.3–8 provides a breakdown of those employees who may be at risk of radiological exposure.

TABLE A.3.2.3–6.—*Lawrence Livermore National Laboratory Secondary and Case Fabrication Mission Surge Operation Annual Chemical Requirements*

Chemical	Quantity (kg)
Solid Chemicals	
Aluminum trihydride	875
Barium nitrate	4
Borax	4
Calcium hydroxide	8,730
Calcium nitrate	45
Calcium oxide	45
Curing agent	1
Diatomaceous earth	730
Epoxy resin	3
Erbium oxide	25
Ferric sulfate	2,200
Graphite	590
Lithium carbonate	350
Magnesium sulfate	30
Methylene diphenyl diisocyanate	30
Nickel compounds	25
Polycure	25
Potassium carbonate	875
PVC plastisol	450
Silicon carbide	15
Sodium bicarbonate	25
Sodium carbonate	135
Sodium molybdate dihydrate	1
Sodium nitrate	440
Sodium potassium	1
Trisodium phosphate	75
Tungsten carbide	0.3
Yttria	45
Zirconium oxide	55
Liquid Chemicals	
Acetic acid	4
Acetone	2
Acetonitrile	45
Anisol	60
Corrosion inhibitor	240
Diamond paste	0.3
Diesel fuel	21,850

TABLE A.3.2.3–6.—*Lawrence Livermore National Laboratory Secondary and Case Fabrication Mission Surge Operation Annual Chemical Requirements*—Continu

Chemical	Quantity (kg)
Ethanol	300
Gasoline	32,000
Hydraulic oil	875
Hydrogen peroxide	220
M-pyrol	15
Methanol	730
Micro/oakite detergent	3
Mineral oil	440
Mold release	2
Nitric acid	300
Nitrogen tetroxide	45
Oxalic acid	0.1
Petroleum oils (lubricants)	440
Potassium chloride	4
Propylene glycol	45
Pump oil	1
PVC primer	1
Solvent 140	220
Toluene 2,4-diisocyanate	30
1,1,1-Trichloroethane	235
Gaseous Chemicals	
Ammonia, anhydrous	2
Argon	407,300
Carbon dioxide	8,750
Chlorine	25
Freon or equal (cleaning)	220
Helium	1,750
Hydrogen	440
Nitrogen	1,450,000
Oxygen	14,550

Note: PVC- polyvinyl chloride.
Source: LLNL 1995e; LLNL 1995i:3.

Waste Management. Radioactive wastes gen from construction activities would be from t rooms in Building 332 which must be deco nated before the installation of new equi Included in this waste is some ducting, flo equipment that would need to be disposed building partitioning materials. Hazardous

TABLE A.3.2.3–7.—*Lawrence Livermore National Laboratory Secondary and Case Fabrication Surge Operation Annual Emissions*

Pollutant	Quantity (t)
Carbon dioxide	3,100
Carbon monoxide	1.0
Chloride	1.6
Chlorine	0.05
Methyl alcohol	4.5
Nitric acid	2.3
Nitrogen dioxide	1.9
Ozone	0.03
Particulate matter	0.1
Pressing lubricant	0.1
Sulfur dioxide	0.02
Sulfuric acid	0.6
Total suspended particulates	3.2
Volatile organic compounds	0
Water vapor	1,040
Radiological Isotope	**Estimated Release**
Uranium-235 (microcuries)	135
Uranium-238 (microcuries)	480

Source: LLNL 1995e; LLNL 1995i:3.

TABLE A.3.2.3–8.—*Lawrence Livermore National Laboratory Secondary and Case Fabrication Surge Operation Workers*

Labor Category	Number of Employees	Employees at Risk of Radiological Exposure
Office and clerical	120	0
Officials and managers	45	10
Operatives	330	150
Professionals	120	50
Technicians	145	40
Total Employees	760[a]	250

[a] Total surge employment. Increase to current employment would be 290.

Source: LLNL 1995e.

would consist primarily of lubricants and coolants that would be recycled or disposed of in accordance with RCRA guidelines. Nonhazardous solids include construction debris, metal, containers, and packaging materials. Liquid nonhazardous wastes would be treated locally and discharged to the sanitary sewer or hauled to an offsite facility for treatment and disposal. Wastes generated during replacement secondary fabrication operations include radioactive, mixed, hazardous, and nonhazardous byproducts. Table A.3.2.3–9 provides an estimate of the quantities of these waste categories effluent volumes as a result of secondary fabrication construction and surge operations. Secondary and case fabrication operations would not generate any spent nuclear fuel, HLW, or TRU wastes.

LLW generated from fabrication activities includes protective clothing, abrasive materials, cutting tools, filters, small equipment, and mop water contaminated with uranium. This waste would be treated by sorting, separation, concentration, and size reduction processes. Processed LLW would be surveyed and shipped to an offsite facility for land disposal.

Mixed wastes would consist of analytical solutions, wipes and rags with acetronitrile and acetone, and organic wastes contaminated with uranium. These wastes would be packaged and shipped to a DOE waste management facility for temporary storage pending treatment and disposal.

Hazardous wastes would include analytical solutions, rags with acetonitrile and acetone, coolants, hydraulic fluid, curing agents, epoxy resins, and plastics. These wastes would be managed and shipped to a commercial waste facility for treatment and disposal.

Nonhazardous (sanitary) wastes would consist of such solid items as office waste, paper, spent tools, and scrap materials. These materials would be hauled to an offsite sanitary landfill for disposal. Sanitary liquids would include sewage waste, uncontaminated process fluids, and mop water. These wastes would be discharged to the local municipal sewage system.

Nonhazardous (other) wastes would be collected and examined before being reclaimed for other recycled use or release to the environment. Examples of this type of waste are paper, glass, and recyclable metals.

TABLE A.3.2.3–9.—*Lawrence Livermore National Laboratory Secondary and Case Fabricatio Waste Volumes*

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations (m^3)	Annual Volume Effluent from Surge Operations (m^3)
Low-Level			
Liquid	None	105	None
Solid	5	370	304
Mixed Low-Level			
Liquid	None	550	550
Solid	None	12	12
Hazardous			
Liquid	11	540	540
Solid	41	18	18
Nonhazardous (Sanitary)			
Liquid	5,050	102,000	102,000
Solid	2,820	4,320	4,320
Nonhazardous (Other)			
Liquid	Included in sanitary	Included in sanitary	Included in sanitary
Solid	255	3,200[a]	None

[a] Recyclable wastes.
Source: LLNL 1995e; LLNL 1995i:3.

A.3.3 Pit Fabrication and Intrusive Modification Pit Reuse

A nuclear weapon has a primary assembly that contains a pit subassembly surrounded by HE. The nuclear material in a pit, typically plutonium, is encased in a shell of nonnuclear metal such as stainless steel. Fabricating and processing the plutonium, and assembling the pit components, is the task that LANL or SRS would perform under this option. For both pit fabrication and intrusive modification, plutonium would be supplied from existing pits that have been retrieved and disassembled.

In order to fabricate replacement pits, the plutonium from disassembled pits first would be processed (dissolution, purification, reduction to metal). Processing also provides means to convert manufacturing scrap and residue (oxides) to metal usable in fabrication operations. Plutonium fabrication involves foundry and mechanical operations, including casting, shaping, machining, bonding, assembly, inspection, and packaging. Intrusive modification would disassemble an existing pit, keeping the plutonium component intact. Modification would be made external to the plutonium and a new outer shell applied. These operations are similar to the assembly and inspection functions for replacement pit fabrication.

Waste management and analytical chemistry activities would also be required for all of the plutonium operations. The block flow diagram of pit fabrication is shown in figure A.3.3–1. In addition to the actual operational aspects of plutonium fabrication, several other important processing functions are required. For example, the plutonium metal is under strict accountability for security and safeguard reasons. These security and safeguard requirements influence some of the facility and personnel needs at LANL or SRS to accomplish this task. Also, the nuclear weapons design/production process includes pit certification and qualification, which influences the facility and personnel needs.

Process Descriptions

Pit Fabrication. Pit fabrication involves preparation of plutonium components (casting, machining, inspecting, and cleaning), assembly of the pits (assembling the plutonium and nonnuclear components then hermetically sealing the pit with a weld), and post-assembly processing of the pits to the stockpile configuration.

Plutonium Processing. Plutonium processing consists of disassembly and metal preparation (obtaining stockpile pits, extracting the plutonium, and purifying the plutonium metal to a reusable form) and chloride and nitrate processing (recovering plutonium from residues generated by the manufacturing processes by using either the chloride or nitrate plutonium recovery processes).

Waste Management. Waste management includes taking waste generated by the manufacturing processes and placing it in a form suitable for final disposal. Wastes to be managed would consist of liquid or solid, TRU or LLW, and may include hazardous or mixed waste.

Analytical Chemistry. Analytical chemistry consists of all analytical measurements required to support pit manufacturing. These chemical evaluations include metal samples from the metal preparation area, plutonium components, samples from the plutonium processing unit processes, all samples that support the disposition of waste, and samples required to maintain physical and administrative control of special nuclear material. Samples supporting waste disposition must meet standards set by the RCRA and EPA.

Storage. Storage would include interim storage of retired stockpile pits awaiting disassembly and new pits awaiting shipment to the nuclear weapons assembly facility, as well as long-term storage of plutonium and oxide.

A.3.3.1 *Reestablish at Los Alamos National Laboratory*

Currently, LANL processes plutonium for RD&T and stockpile support purposes on site. Reconfiguring and upgrading these existing plutonium laboratory facilities in TA-55 is the proposed approach to provide a Pit Fabrication and Intrusive Modification Pit Reuse Facility. Other nuclear facilities to be used for this effort are located in TAs -3, -8, -35, -50, and -54 (as shown in figure A.3.3.1–1). Within TA-55 is the Plutonium Facility (PF-4), which includes a Pit Fabrication Facility in the 300 Area and facilities for

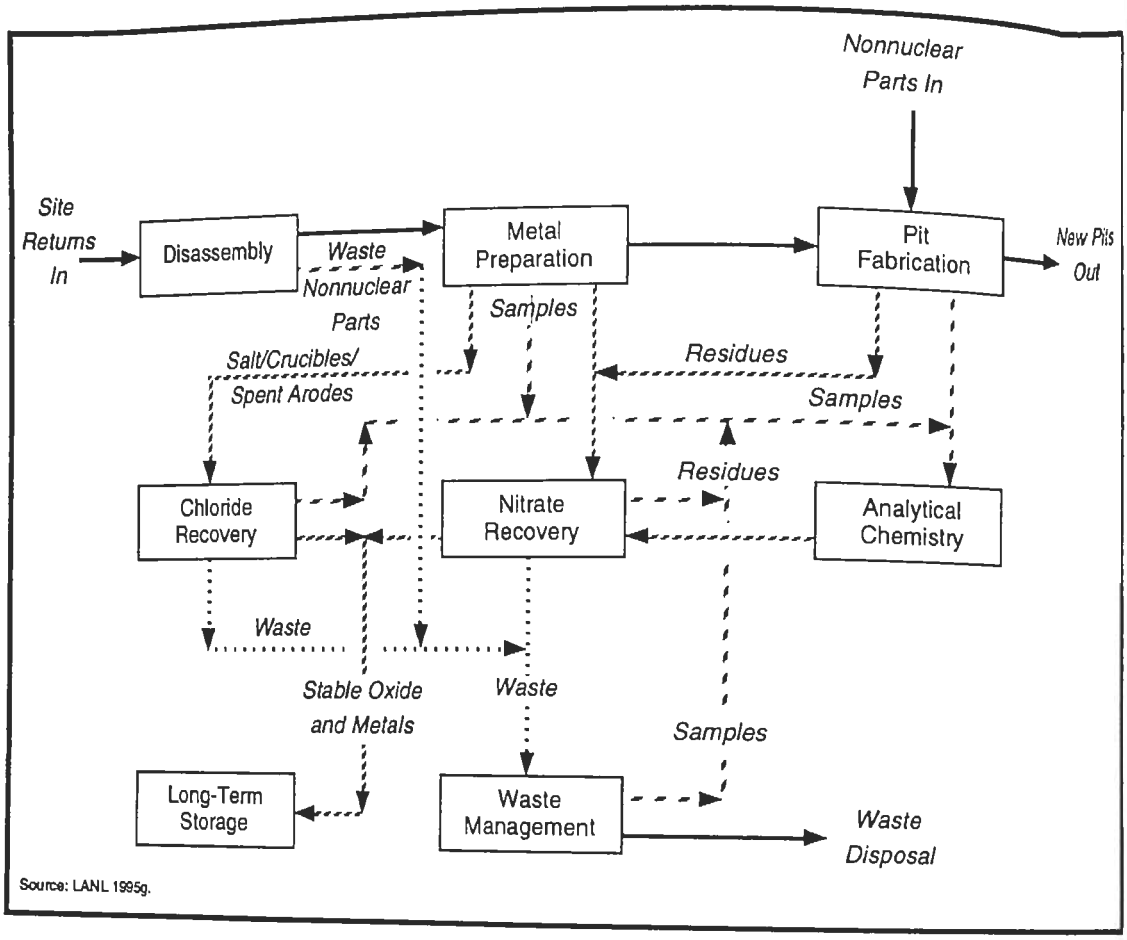


Figure A.3.3–1.—*Block Flow Diagram of Pit Fabrication.*

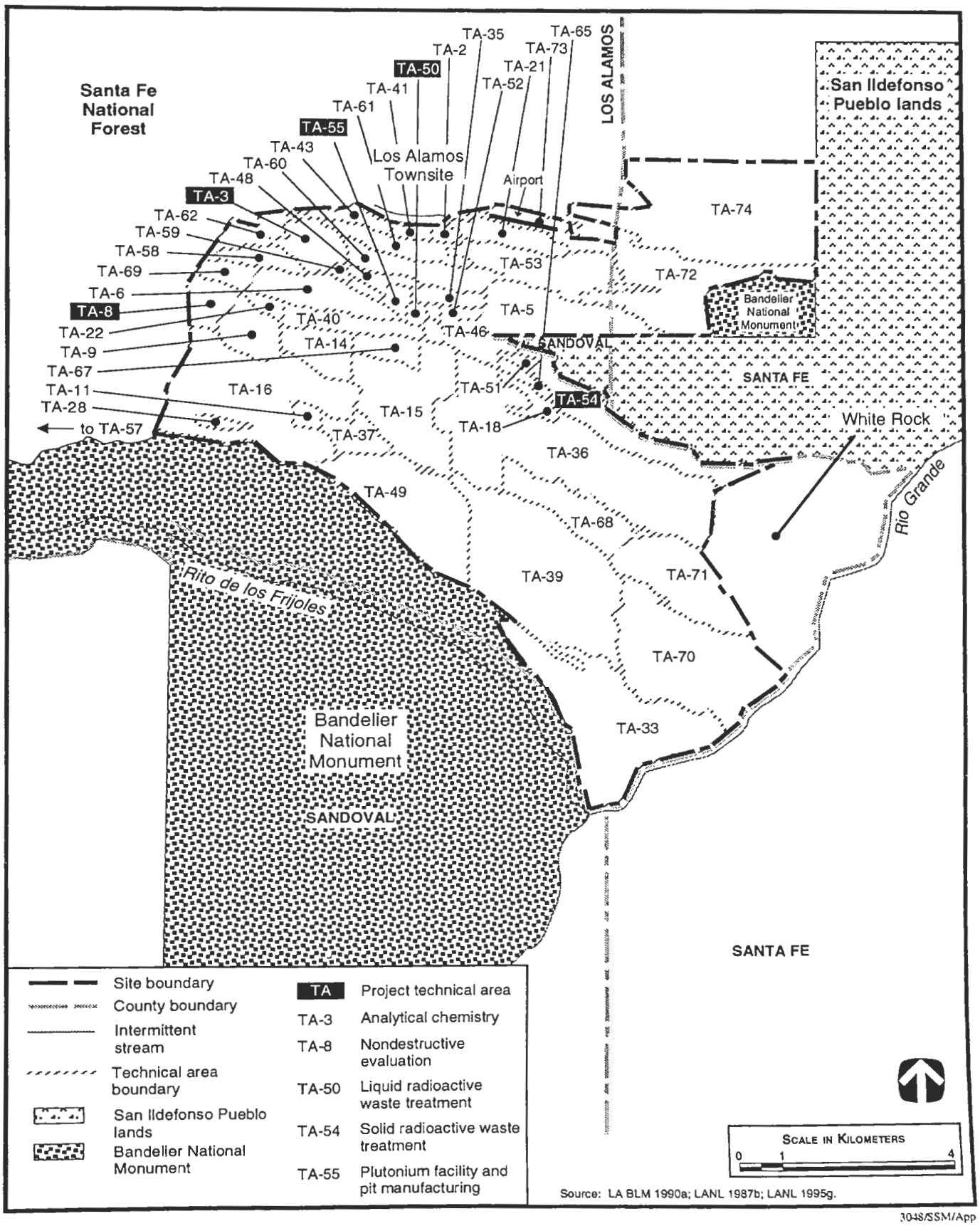


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FIGURE A.3.3.1–1.—*Pit Fabrication Alternative Technical Areas at Los Alamos National Laboratory.*

plutonium and waste processing in the 400 Area (as shown in figure A.3.3.1–2). TA-3 is a key area; it contains the Sigma Complex, Chemistry and Metallurgy Research building, and main machine shop. Another key area, TA-35, has the physical vapor deposition coating building. Nondestructive evaluation is carried out in a facility in TA-8. Radioactive waste is treated in TA-50 (liquid) and TA-54 (solid). The facilities that are currently used by stockpile surveillance activities would be shared with the pit fabrication group until dedicated facilities become available. The current stockpile Pit Rebuild Program at LANL would be absorbed within the pit fabrication effort as the activity is the same; only the number of pits produced would change. The number of pits fabricated annually is projected to be from 20 to 50 (depending on equipment availability), but could be about 80 if surge mode (multiple shifts, personnel overtime, and use of equipment to full capacity) were exercised. The key building descriptions for the Pit Fabrication and Intrusive Modification Pit Reuse Facility at LANL are shown in table A.3.3.1–1.

The pit fabrication process flow at LANL would begin with old pits from the weapons retirement process being routed to a disassembly area. The plutonium metal from disassembled pits would be purified before transfer to the fabrication area. Residues generated in the disassembly/metal purification areas are primarily chloride salts, crucibles, and chloride-contaminated scrap. The bulk of the residual plutonium would be purified and converted to plutonium metal in the chloride recovery area. Recovered plutonium metal would also be sent to the fabrication area. During fabrication, plutonium metal would be cast into the desired near-net-shape and machined to the final shape with desired tolerances. The finished components would then be assembled with other nonplutonium materials into the new weapon pit component. These new pits would then be sent to the weapon assembly facility. During the casting and machining operations, a number of residues would be generated that require processing and would subsequently undergo nitrate recovery operations. In nitrate recovery, the residues are purified and converted to oxide for return to the reduction operations. Solid and liquid wastes from processing areas would be routed to waste management facilities for processing into a disposable waste form. Analytical laboratories provide chemical analyses of plutonium metal, oxides, solutions, and wastes.

Tables A.3.3.1–2 and A.3.3.1–3 summarize resource requirements for facility modification and operation of the Pit Fabrication Facility. Table A.3.3.1–4 summarizes the bulk quantities of chemicals that would be used in the pit fabrication processes. These quantities assume the surge mode of 80 new pits per year.

TABLE A.3.3.1–1.—*Los Alamos National Laboratory Pit Fabrication Facility Data*

Building	Footprint (m^2)	Number of Levels	Special Nuclear Material Permitted	Construction
TA-55, PF-4 Plutonium Facility	14,000	2	Yes	Concrete post and beam with concrete masonry unit in-fill walls
TA-55, PF-4 Nuclear Material Storage Facility			Yes	Concrete post and beam with concrete masonry unit in-fill walls
TA-3, SM-29 Chemistry and Metallurgy Research Building	51,100	3	Yes	Concrete post and beam with concrete masonry unit in-fill walls
TA-3, SM-141 Nonnuclear Component Fabrication	1,860	1	No	Concrete post and beam with concrete masonry unit in-fill walls
TA-3, SM-66 Sigma Building	15,800	1	No	Concrete post and beam with concrete masonry unit in-fill walls
TA-3, SM-39 Nonnuclear Shops Building	7,660	1	No	Concrete post and beam with concrete masonry unit in-fill walls

Source: LANL 1995g.

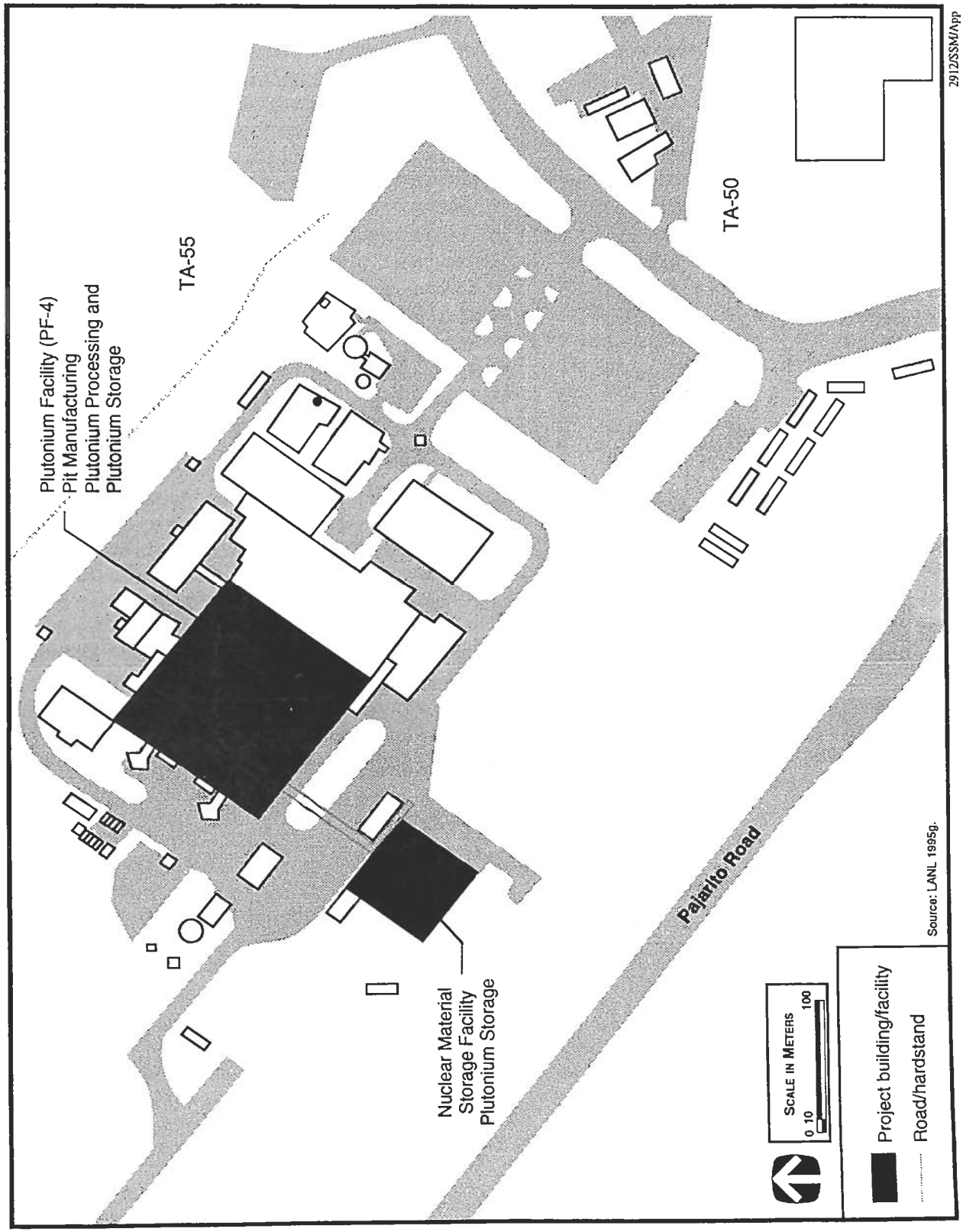


FIGURE A.3.3.1–2.—*Pit Fabrication Site Plan at Los Alamos National Laboratory, TA-55.*

TABLE A.3.3.1–2.—*Los Alamos National Laboratory Pit Fabrication Construction Requirements*

Requirement	Consumption
Material/Resource	
Electrical energy (MWh)	Minimal
Peak electrical demand (MWe)	Minimal
Concrete (m^3)	Minimal
Steel (t)	Minimal
Gasoline, diesel, and lube oil (L)	Minimal
Industrial gases[a] (m^3)	Minimal
Water (L)	Minimal
Land (ha)	None
Employment	
Total employment (worker years)	216
Peak employment (workers)	138
Construction period (years)	3

[a] Cubic meters at standard temperature and pressure.
Source: LANL 1995g.

TABLE A.3.3.1–3.—*Los Alamos National Laboratory Pit Fabrication Surge Operation Annual Requirements*

Requirement	Consumption
Resource	
Electrical energy (MWh)	5,480
Peak electrical demand (MWe)	0.7
Liquid fuel[a] (L)	None
Natural gas[b] (m^3)	30,900
Water (L)	30,200,000
Plant Footprint (ha)	NA[c]
Employment[d] (Workers)	628

[a] Used only for utility backup.
[b] Cubic meters at standard temperature and pressure.
[c] Within existing facilities.
[d] Total full time equivalent employment. Increment from current employment would be 260.
Note: NA - not applicable.
Source: LANL 1995b:4; LANL 1995g.

Waste Management. The liquid and solid hazardous and nonhazardous wastes generated during building modification would include concrete and steel construction waste materials. The steel waste would be recycled as scrap material before completing construction. The remaining nonhazardous wastes generated during construction would be

TABLE A.3.3.1–4.—*Los Alamos National Laboratory Pit Fabrication Surge Operation Annual Chemical Requirements*

Chemical	Quantity (kg)
Solid Chemicals	
Aluminum nitrate	2,041
Aluminum sulfate	2,041
Bentonite	1,021
Calcium fluoride	62
Calcium carbonate	1,021
Calcium chloride	227
Diatomaceous earth	45,360
Ferrous ammonium sulfate	5
Hydroxylamine hydrochloride	23
Iron, magnesium, calcium	11
Magnesium hydroxide	340
Oxalic acid	748
Portland cement	45,360
Resins	23
Sodium carbonate	57
Sodium hydroxide	28
Sodium nitrite	96
Sodium sulfite	794
Urea	20
Liquid Chemicals	
Carbon dioxide	17
Film developer, fixer, toner	1,043
Hydrochloric acid	1,497
Hydrofluoric acid	340
Hydroger peroxide	1,996
Hydroxylamine nitrate	658
Nitric acid[a]	3,420
Nitrogen	57
Potassium hydroxide	17,010
Sodium hydroxide	2,268
Gaseous Chemicals	
Argon	170,100
Chlorine	340
Helium	23
Hydrogen chloride	11
Nitrogen	1,360,800
Oxygen	1,814

[a] Annual makeup requirement with recycling. Total first year requirement is 32,886 kgs.
Source: LANL 1995b:4.

disposed of by the construction contractor. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes generated during construction would consist of such materials as waste adhesives, oils, cleaning fluids, solvents, and coatings. Hazardous waste would be packaged in DOT-approved containers and shipped offsite to commercial RCRA-permitted treatment, storage, and disposal facilities. Small amounts of radioactive waste would be generated during construction.

The project design considers and incorporates waste minimization and pollution prevention. Segregation of activities that generate radioactive and hazardous wastes would be employed, where possible, to avoid the generation of mixed wastes. Where applicable, treatment to separate radioactive and nonradioactive components would be performed to reduce the volume of mixed wastes and to provide for cost-effective disposal for recycling. To facilitate waste minimization, where possible, nonhazardous materials would be substituted for those materials which contribute to the generation of hazardous or mixed waste. Production processes would be configured with minimization of waste production given high priority. Material from the waste streams would be treated to facilitate disposal as nonhazardous wastes, where possible. Future D&D considerations have also been incorporated into the design.

Table A.3.3.1–5 presents the estimated annual waste volumes from the Pit Fabrication and Reuse Facility during modification activities and operation. Solid and liquid waste streams are routed to the waste management system. Figures A.3.3.1–3 through A.3.3.1–5 depict the waste management system. Solid wastes would be characterized and segregated into TRU, LLW, hazardous, and mixed wastes, then treated to a form suitable for disposal or storage within the facility. Liquid wastes would be treated onsite to reduce hazardous/toxic and radioactive elements before discharge or transport. All fire-sprinkler water discharged in process areas is contained and treated as process wastewater, when required.

Spent Nuclear Fuel. The Pit Fabrication and Reuse Facility would not generate any spent nuclear fuel.

Transuranic Waste. TRU waste would be generated from operation of the Pit Fabrication and Reuse Facility and would consist of glass, leaded gloves, plastics, equipment, metals, and heater elements. These wastes would be shipped to WIPP for disposal.

Low-Level Waste. LLW would be generated from operation of the Pit Fabrication and Reuse Facility and would consist primarily of plastics, metal, cement sludge, and vacuum filters. Liquid LLW would be sent either by truck or industrial drain to TA-50 for processing. The liquid LLW treatment facilities include a chemical treatment and ion-exchange plant at the radioactive liquid waste treatment facility and a chemical treatment plant. The waste would be processed, with radioactive constituents removed, in accordance with the NPDES permit. Low-level solids would be disposed of in 0.1-m^3 (2-ft^3) boxes at TA-54, Area G.

Mixed Low-Level Waste. No mixed LLW is expected to be generated. If any were to be generated, it would be managed in accordance with LANL Site Treatment Plan.

Hazardous Waste. Liquid hazardous wastes would be generated from solvents from cleaning operations and residue from painting and bonding operations. The cleaning solvents selected would be from a list of nonhalogenated solvents. Hazardous chemical wastes would be treated at commercial offsite RCRA-permitted facilities until completion of the Hazardous Waste Treatment Facility. The remaining liquid waste would be treated by gravity settling and discharged through an NPDES-permitted outfall. No solid hazardous wastes are expected to be generated.

Nonhazardous (Sanitary) Waste. Sewage wastewater and process wastewater would be sent by drain to the sanitary wastewater treatment plant (TA-46). Treated effluents would be disposed of by either sanitary drains or through permitted NPDES outfalls. Cooling tower blowdown and overflow would be discharged through outfalls permitted by the State of New Mexico. Sludge and other solid sanitary waste would be disposed onsite at the Sandia Canyon site (TA-61).

Nonhazardous (Other) Waste. Nonhazardous (other) wastes would be disposed of in a permitted landfill or discharged through permitted NPDES outfalls.

TABLE A.3.3.1–5.—*Los Alamos National Laboratory Pit Fabrication Waste Volumes (80 Pits Per Year)*

Waste Category	Annual Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations (m^3)	Annual Volume Effluent from Surge Operation (m^3)
Transuranic			
Liquid	None	5	None
Solid	6[a]	43	60
Mixed Transuranic			
Liquid	None	None	None
Solid	None	2	2
Low-Level			
Liquid	None	15	None
Solid	12[b]	386	393
Mixed Low-Level			
Liquid	None	None	None
Solid	None	None	None
Hazardous			
Liquid	0.06	2	2
Solid	51	None	None
Nonhazardous (Sanitary)			
Liquid	None	12,300[c]	12,300
Solid	None	552[d]	552
Nonhazardous (Other)			
Liquid	None	Included in sanitary	Included in sanit
Solid	26[e]	Included in sanitary	Included in sani

[a] Over a 3-year construction period a total of 27 t (30 tons) of associated piping and ventilation ductwork from glove boxes w be generated. For volume conversion, 1,500 kg/m^3 was assumed.

[b] Over a 3-year construction period a total of 41 t (45 tons) of glove boxes and 14 t (15 tons) of associated piping and ventil ductwork would be generated. For volume conversion, 1,500 kg/m^3 was assumed.

[c] Assumes 50 gal/day/person/shift, with parameters of 250 days/yr, and 260 total additional employees for three shifts.

[d] Assumes 0.3 ft^3/day/person/shift, with parameters of 250 days/yr, 3 shifts/day, and 260 total additional employees for three

[e] Includes 0.15 t (0.175 tons) of steel assuming a density of 0.127 t/m^3.

Source: LANL 1995g; LANL 1996e:1.

A.3.3.2 *Reestablish at Savannah River Site*

The Pit Fabrication and Intrusive Modification Pit Reuse Facility at SRS would use existing hardened facilities but with all new equipment. The facilities available for this mission include the Separations Areas, F-Area, and H-Area (figure A.3.3.2–1). All aspects of pit component fabrication would be included: pit fabrication, plutonium processing, and waste management. Pit fabrication could be located in the 232-H Building or the F-Canyon. Plutonium processing would be in the F-Canyon facilities. The intrasite transfers of plutonium between areas would be in the form of metal ingots, buttons, and scrap as well as small quantities of oxide. Any liquid transfers would be performed through vessels and piping with secondary and tertiary containment system nonnuclear portions of the pit component w fabricated and manufactured elsewhere, then to SRS as finished parts. Potentially tritium inated pits would not be handled at SRS; rat would be sent to LANL. The total number of ricated annually is projected to be in the ran (normal operations), 50 (design capacity, operations), or 120 in the surge mode (multip personnel overtime, and use of equipmen capacity).

Currently, Building 232-H is being used fo processing and handling operations. These are being moved to the Replacement Tritium The building would be refurbished, leaving

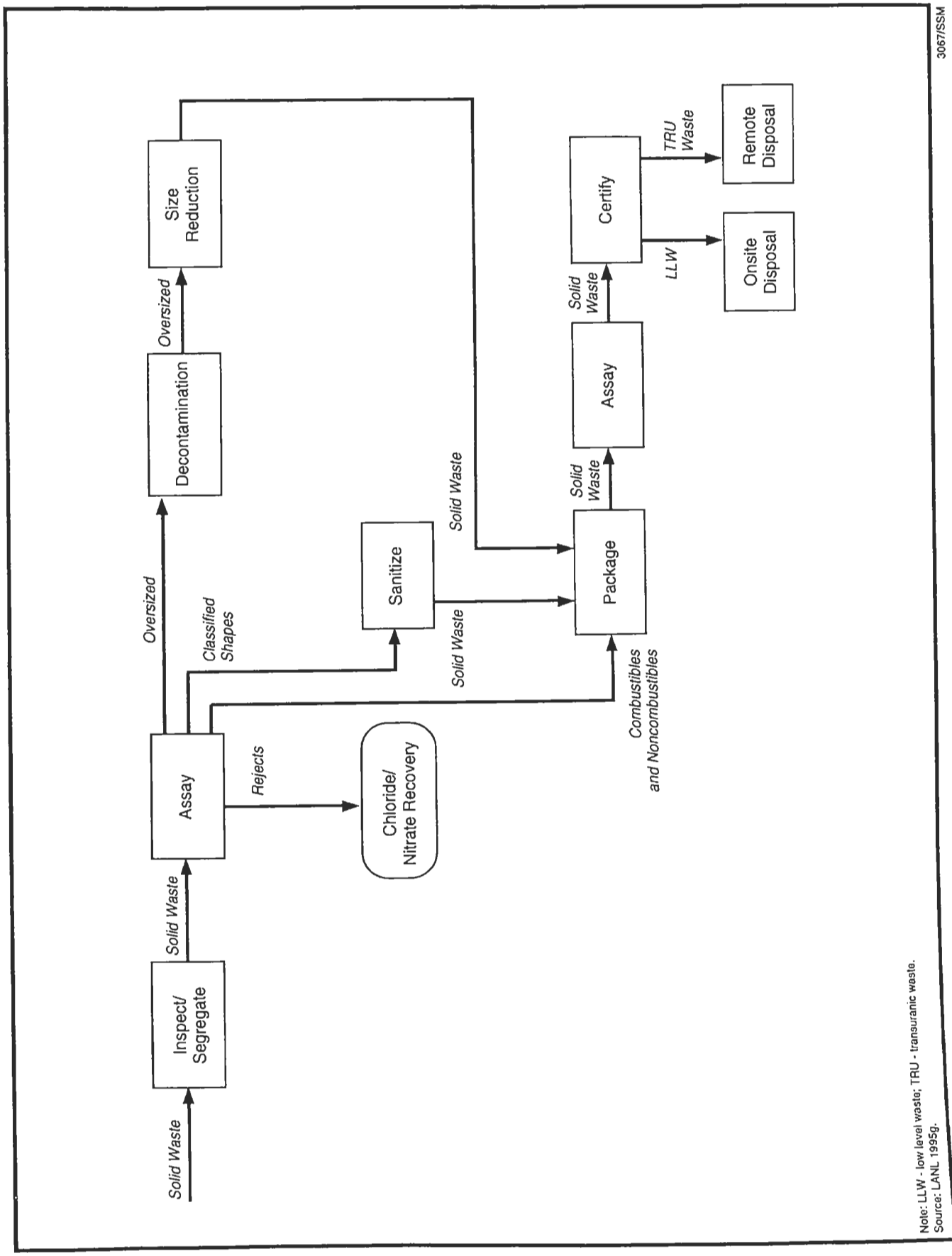
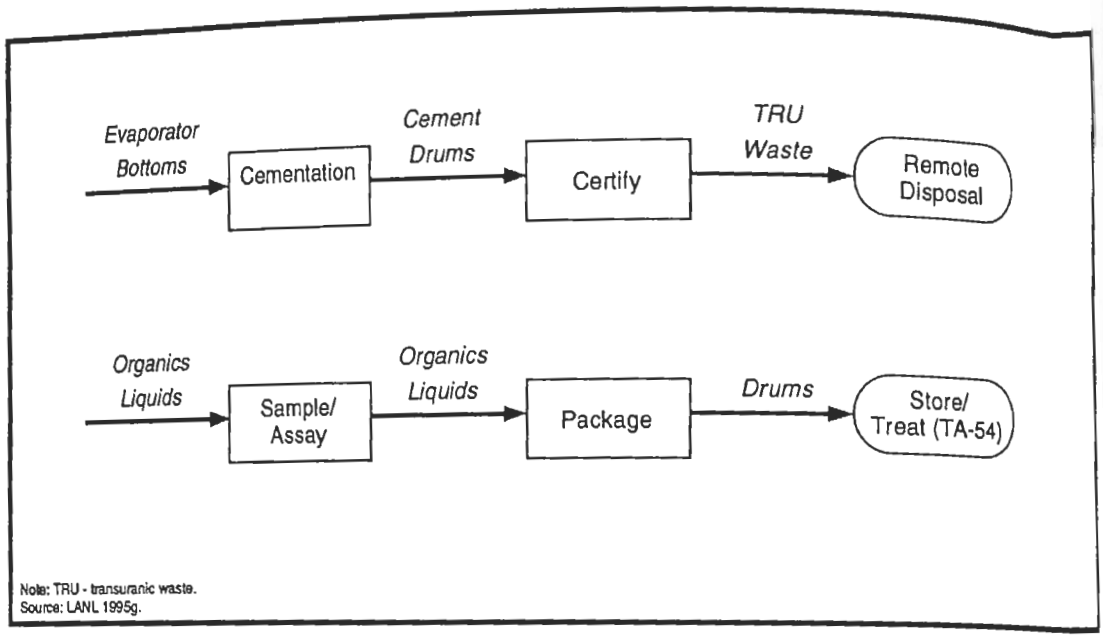


FIGURE A.3.3.1-3.—*Solid Waste Management at Los Alamos National Laboratory, TA-55.*



Note: TRU - transuranic waste.
Source: LANL 1995g.

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FIGURE A.3.3.1–4.—*Liquid Waste Management at Los Alamos National Laboratory, TA-55.*

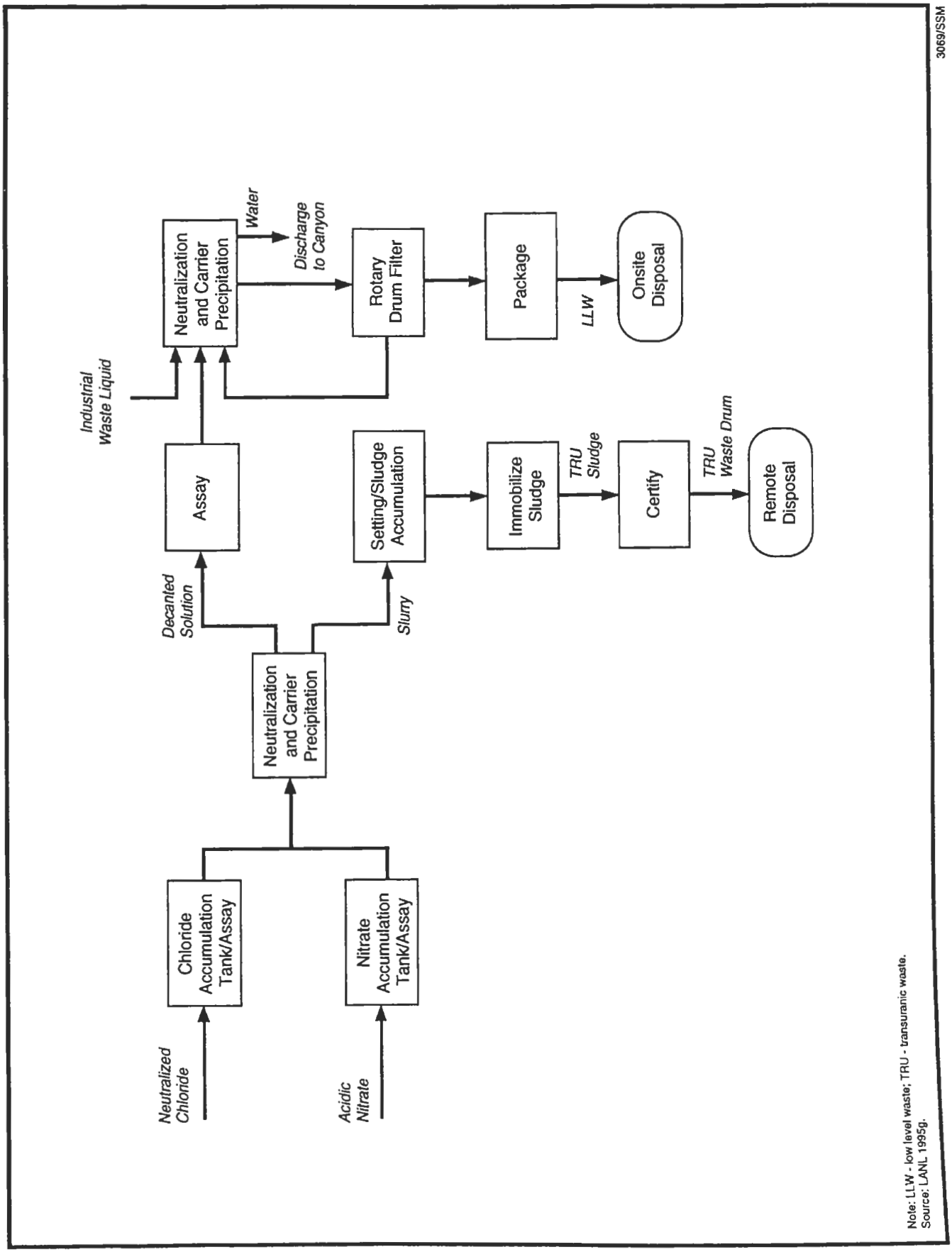

FIGURE A.3.3.1–5.—*Liquid Waste Management at Los Alamos National Laboratory, TA-50.*

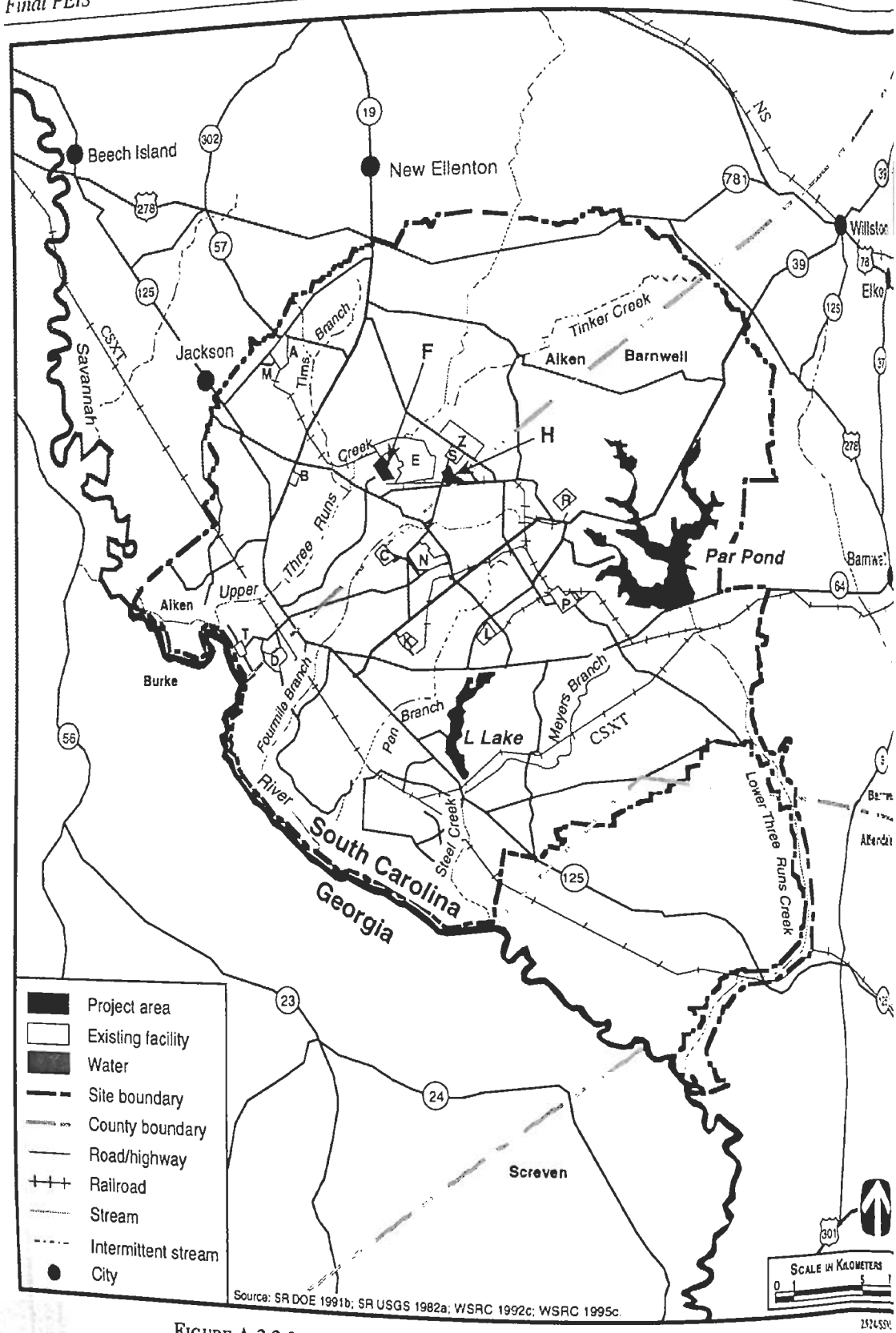

FIGURE A.3.3.2–1.—*Pit Fabrication Areas at Savannah River Site.*

space for pit fabrication. The space would be in a hardened facility and essentially free of tritium contamination. Those areas with high levels of tritium contamination would be isolated from the pit fabrication areas. Adjacent nonhardened areas would be used for receiving and handling nonnuclear components or direct service support to the pit fabrication process. Figure A.3.3.2–2 shows the H-Area proposed pit fabrication facilities.

The F-Canyon facilities have adequate noncontaminated hardened areas that can house the plutonium processing functions. The canyon includes the new, never operated, plutonium storage facility, the new special recovery facility, and a vacant production space that was previously decontaminated. Only minor modifications would be required to the glove boxes and equipment in the two new facilities. The plutonium processing operations would also handle the receiving, handling, and disposition of surplus plutonium. The existing waste management systems and laboratory facilities can be used to support the process.

The infrastructure at SRS includes liquid and solid waste management; analytical laboratories; security systems; ES&H systems; training facilities; and research, development, and demonstration facilities. The waste management operations are collocated with the plutonium processing facilities. This allows for the expedient transfer of byproducts from the plutonium purification process to the liquid waste stream, which is subsequently vitrified with high-level waste in the existing Defense Waste Processing Facility.

SRS has the existing support infrastructure to handle plutonium processing. Feedstock for the pit fabrication process would be plutonium metal. Plutonium would be received from offsite via safe secure trailer, unloaded into a staging area, then moved to the plutonium storage facility until needed. Once the retired pit is determined not to be contaminated, it would enter the disassembly process where the nonnuclear and other nuclear components would be removed from the plutonium. The plutonium would be collected and purified while the nonnuclear parts would be declassified and sent to solid waste treatment, and the other nuclear parts would be cleaned and sent to staging to await offsite transport. The purified plutonium would be converted back to metal and would enter the pit fabrication process. The listing of the major support facilities for the Pit Fabrication and Intrusive Modification Pit Reuse Facility is shown in table A.3.3.2–1.

The plutonium fabrication process is an abbreviated version used by the Rocky Flats Environmental Technology Site. Though there are several pit types, the process is basically the same. The process consists of casting parts to the near net-shape, machining the surfaces of the casting to achieve the final shape, and performing tests on the completed parts to assure suitability. After this inspection, the plutonium components are cleaned and assembled with the nonnuclear components to form a pit that is then welded together. Once the plutonium is encapsulated, it may then be safely removed from the glove box, certified, and stored or shipped offsite as needed.

Nonnuclear components used in the new pits would be received from offsite. After inspection these parts would be stored in Building 704-55H until needed for either newly fabricated or reused pits. Some nonnuclear parts require a vapor deposition coating of material be applied. Generally all of these coatings would be produced in a vacuum environment using either a thermal evaporation or plasma sputtering process. Tables A.3.3.2–2 and A.3.3.2–3 show resource requirements for facility modification and surge operation of the Pit Fabrication Facility. Table A.3.3.2–4 shows annual chemical usage for surge operation.

Waste Management. The solid and liquid nonhazardous wastes generated during modification activities would include concrete and steel construction waste materials and sanitary wastewater. The steel waste would be recycled as scrap material before completing construction. Liquid waste which is primarily sanitary water would be treated as sanitary plant waste. Solid nonhazardous waste would consist primarily of office trash and sludge from sanitary wastewater treatment. Nonrecyclable portions of this waste would be sent to a permitted landfill after volume reduction practices such as compacting and shredding had been performed. No liquid hazardous waste would be generated other than the lubrication oils and coolants needed to maintain the construction equipment. Solid hazardous waste would consist primarily of solvent

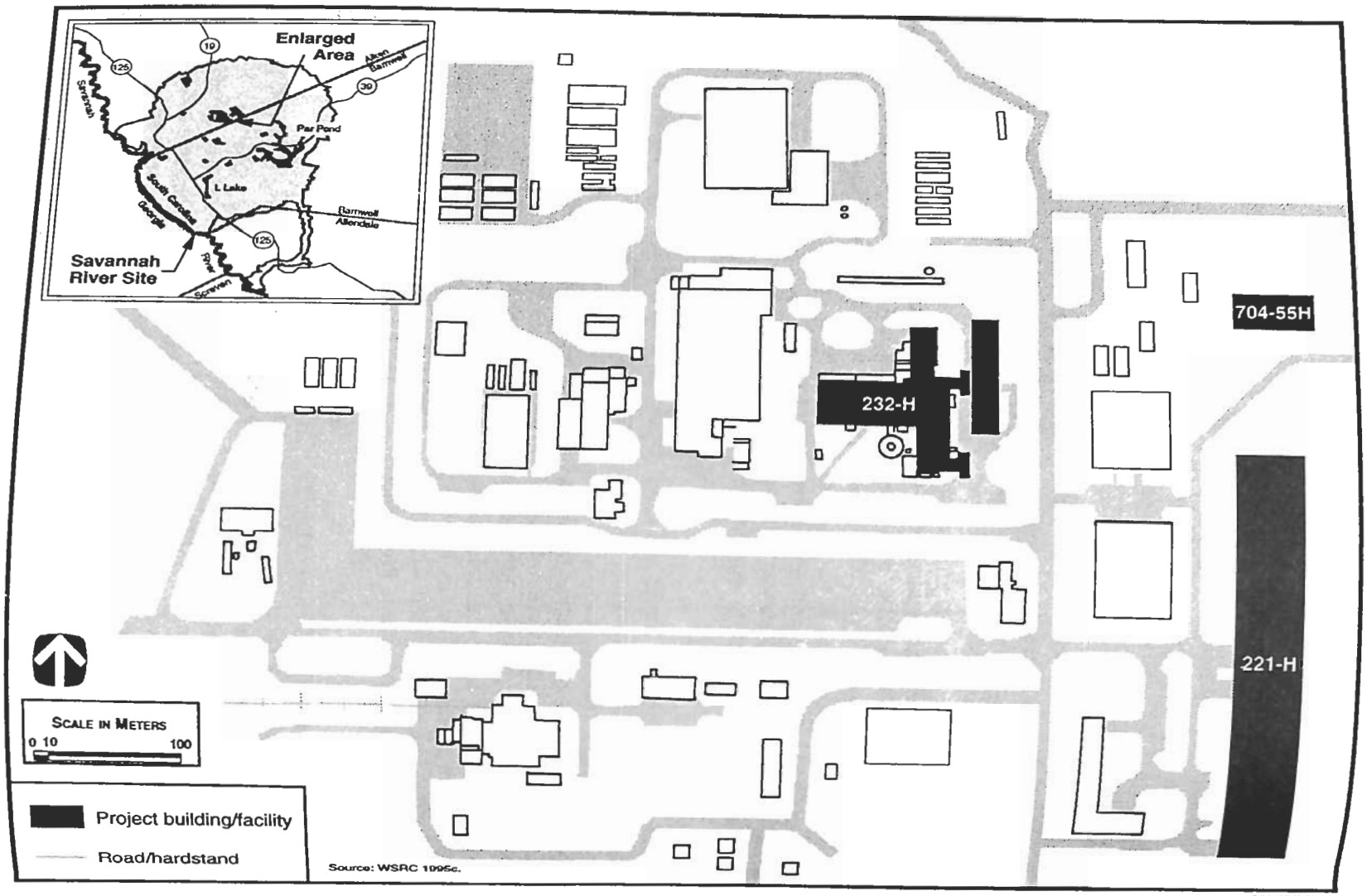

FIGURE A.3.3.2–2.—*Pit Fabrication Site Plan at Savannah River Site.*

TABLE A.3.3.2–1.—*Savannah River Site Pit Fabrication Facility Data*

Building	Facility Type	Footprint (m^2)	Number of Levels	Construction
211-F	Supply tanks	NA	NA	Outside/metal frame
221-F	Feed preparation	4,060	6	Concrete/metal frame
292-F	Canyon exhaust fan house	1,160	1	Concrete
294-F	Sand filters	2,230	NA	Concrete
294-1F	Sand filters	3,340	NA	Concrete
703-F	Administration building	1,860	1	Metal frame
704-F	Administration building	1,130	1	Metal frame
707-F	Administration building	1,490	1	Metal frame
707-7F	Administration building	1,490	1	Metal frame
717-F	Mock-up/maintenance shops	1,170	2	Metal frame
723-F	Laundry	1,060	1	Metal frame
772-F	Laboratory	3,850	2	Concrete/metal frame
772-1F	Laboratory	280	1	Concrete/metal frame
232-H	Manufacturing	4,840	3	Concrete
232-1H	Shop and storage	1,210	1	Metal frame
235-H	Tritium facility office	780	1	Metal frame
703-H	Administration building	1,860	1	Metal frame
704-H	Administration building	1,390	1	Metal frame
704-2H	Administration building	4,670	1	Metal frame
704-55H	Administration building	1,230	1	Metal frame
707-H	Administration building	1,770	1	Metal frame
766-H	Training facility	7,620	2	Metal frame

Note: NA - not applicable.
Source: WSRC 1995c.

TABLE A.3.3.2–2.—*Savannah River Site Pit Fabrication Construction Requirements*

Requirement	Consumption
Material/Resource	
Electrical energy (MWh)	15
Peak electrical demand (MWe)	0.37
Concrete (m^3)	1,600
Steel (t)	249
Gasoline, diesel, and lube oil (L)	175,000
Industrial gases (m^3)[a]	3,780
Water (L)	30,000,000
Land (ha)	2
Employment	
Total employment (worker years)	801
Peak employment (workers)	288
Construction period (years)	5

[a] Cubic meters at standard temperature and pressure.
Source: WSRC 1995c.

TABLE A.3.3.2–3.—*Savannah River Site Pit Fabrication Surge Operation Annual Requirements*

Requirement	Consumption
Resource	
Electrical energy (MWh)	9,700
Peak electrical demand (MWe)	1.6
Liquid fuel (L)	28,400
Natural gas (m^3)[a]	None
Water (L)	46,200,000
Coal (t)	1,090
Plant Footprint (ha)	NA[b]
Employment (Workers)	813

[a] Cubic meters at standard temperature and pressure.
[b] Contained within existing facilities.
Note: NA - not applicable.
Source: WSRC 1995c.

rags and empty containers of hazardous materials. Hazardous waste would be packaged in DOT approved containers and shipped offsite to commercial RCRA-permitted treatment,storage, and disposal facilities. No radioactive waste would be generated during construction.

TABLE A.3.3.2–4.—*Savannah River Site Pit Fabrication Surge Operation Annual Chemical Requirements*

Chemical	Quantity (kg)
Solid Chemicals	
Calcium carbonate	642
Calcium metal	227
Hydroxylamine nitrate	633
Magnesium oxide	383
Sodium hydroxide	4,983
Sodium nitrite	206
Water treatment chemicals	64
Liquid Chemicals	
Betz 25k series corrosion inhibitor	200
Betz Slimcide (CE-77 PE)	34
Cleaning/developing fluids	340
Hydrofluoric acid	10
Nitric acid[a]	3,420
Liquid nitrogen	4,000
Polyphosphate	191
Sodium hypochlorite	96
Gaseous Chemicals	
Argon	3,924
Carbon dioxide	45,360
Hydrogen	6
Hydrogen fluoride	442
Nitrogen	2,790

[a] Annual makeup requirement with recycling.
Source: WSRC 1995c.

The Pit Fabrication Facility considers and incorporates waste minimization and pollution prevention. Segregation of activities that generate radioactive and hazardous wastes would be employed, where possible, to avoid the generation of mixed wastes. Where applicable, treatment to separate radioactive and nonradioactive components would be performed to reduce the volume of mixed wastes and provide for cost-effective disposal or recycle. To facilitate waste minimization, where possible, nonhazardous materials would be substituted for those materials which contribute to the generation of hazardous or mixed waste. Production processes would be configured with minimization of waste production given high priority. Material from the waste streams would be treated to facilitate disposal as nonhazardous wastes, where possible. Future D&D considerations have also been incorporated into the design.

Table A.3.3.2–5 presents the estimated annual waste volumes from the Pit Fabrication Facility during modification activities and operation for the base case surge. Solid and liquid waste streams would be routed to the waste management system.

Figure A.3.3.2–3 depicts the overall waste management system at SRS. Additional figures by waste category are available in appendix section H.2. Solid wastes would be characterized and segregated into TRU, low-level, mixed, hazardous, and nonhazardous, then treated to a form suitable for disposal or storage. Liquid wastes would be treated onsite to reduce hazardous/toxic and radioactive elements before discharge or transport. All fire sprinkler water discharged in process areas would be contained and treated as process wastewater, when required.

Spent Nuclear Fuel. The Pit Fabrication Facility would not generate any spent nuclear fuel.

High-Level Waste. The Pit Fabrication Facility would not generate any operational HLW. However, as a result of the plutonium recovery and purification processes, plutonium processing would generate a liquid TRU waste that would be managed as a high specific activity waste at SRS. As shown in figure A.3.3.2–3, one of the final waste products from the treatment of this waste is a glass log composed of comingled TRU waste from pit fabrication and legacy HLW.

Transuranic Waste. As noted above, plutonium processing would generate a liquid TRU waste as a result of the plutonium recovery and purification processes. This waste would have a high specific activity and would be managed in accordance with the SRS High-Level Waste Management Plan as outlined in appendix H.2.2. Solutions from both processes would be transferred to F-Canyon, evaporated, and the resulting evaporator bottoms neutralized with sodium hydroxide and transferred to the F Area Tank Farm. Excess oxalic acid in the precipitation filtrates would be destroyed during filtrate evaporation. The residual sludge consisting primarily of americium and plutonium would be fed to the Defense Waste Processing Facility for conversion to a HLW form using borosilicate glass. The waste would then be immobilized by melting and pouring into stainless steel cylinders which would be stored until a repository is available.

TABLE A.3.3.2–5.—*Savannah River Site Pit Fabrication Waste Volumes (120 Pits Per Year)*

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations (m^3)	Annual Volume Effluent from Surge Operations (m^3)
Transuranic			
Liquid	None	28[a]	None
Solid	None	129[b]	129[b]
Mixed Transuranic			
Liquid	None	None	None
Solid	None	11	11
Low-Level			
Liquid	None	80[c]	None
Solid	None	88[d]	34
Mixed Low-Level			
Liquid	None	None	None
Solid	None	None	None
Hazardous			
Liquid	<0.01	<1	None
Solid	8[e]	None	<0.01[f]
Nonhazardous (Sanitary)			
Liquid	3,020	46,160	46,140[g]
Solid	23	1,450	1,580
Nonhazardous (Other)			
Liquid	None	None	None
Solid	500[h]	1,450[i]	None

[a] At SRS, this would be managed as high specific activity liquid waste which would be combined with HLW at the Tank Farm and then processed in accordance with the High-Level Waste Management Plan as depicted in appendix section H.2.2. The resultant waste forms include 0.61 glass logs composed of comingled TRU waste from pit fabrication and legacy HLW, and LLW saltstone. Based on aqueous alternative process for Complex 21; denitrated water=49.3 L/kg Pu metal processed and discarded filtrates=6.9 L/kg plutonium metal. Neutralized with 0.2 L of 50 percent caustic per kg of waste.

[b] One-half of this volume is considered intermediate-level waste at SRS and would be disposed of in the intermediate-level waste vaults in E-Area. It is managed as TRU waste because it contains beta or gamma emitters that produce a dose equal to or greater than 200 millirem/hr at 5 cm (2 in) from an unshielded container.

[c] Based on aqueous alternative process for Complex 21; 166 L of recycle water per kg of Pu metal processed. Assume "recycle" water sent to Effluent Treatment Facility; recovered acid is recycled.

[d] Incinerable=58 m^3, nonincinerable=30 m^3.

[e] Includes 7.6 m^3 (9.9 yd^3) of D&D wastes such as wall material contaminated with asbestos.

[f] Treatment of liquid hazardous wastes results in solid hazardous ash. Volume reduction is 200:1.

[g] Assumes 350:1 wastewater to sludge ratio for treatment of liquid sanitary waste.

[h] Includes 1.5 m^3 (2 yd^3) of concrete and 0.8 t (0.2 tons) of steel. Includes 498 m^3 (651 yd^3) of D&D wastes such as ductwork, concrete, electrical wiring, and equipment.

[i] Recyclable wastes.

Source: SRS 1996a:2; WSRC 1995c.

The solid TRU waste would consist primarily of graphite molds, crucibles, failed equipment, leaded gloves, filters, and combustible materials such as plastics and rags used during glove box operations. Approximately one-half of the volume of waste reported as TRU is considered as intermediate-level waste at SRS and would be disposed of in the intermediate-level waste vaults in E-Area. Intermediate-level waste is managed as TRU waste at SRS because it contains beta or gamma emitters that produce a dose equal to or greater than 200 mrem/hr at 5 centimeters (cm) (2 inches [in]) from an unshielded container. TRU waste destined for disposal in a Federal repository would be certified to meet the WIPP waste acceptance criteria and packaged in drums at the Pit Fabrication Facility then placed in interim storage. Disposal is planned for WIPP, once it has been determined to be a suitable repository for TRU wastes.

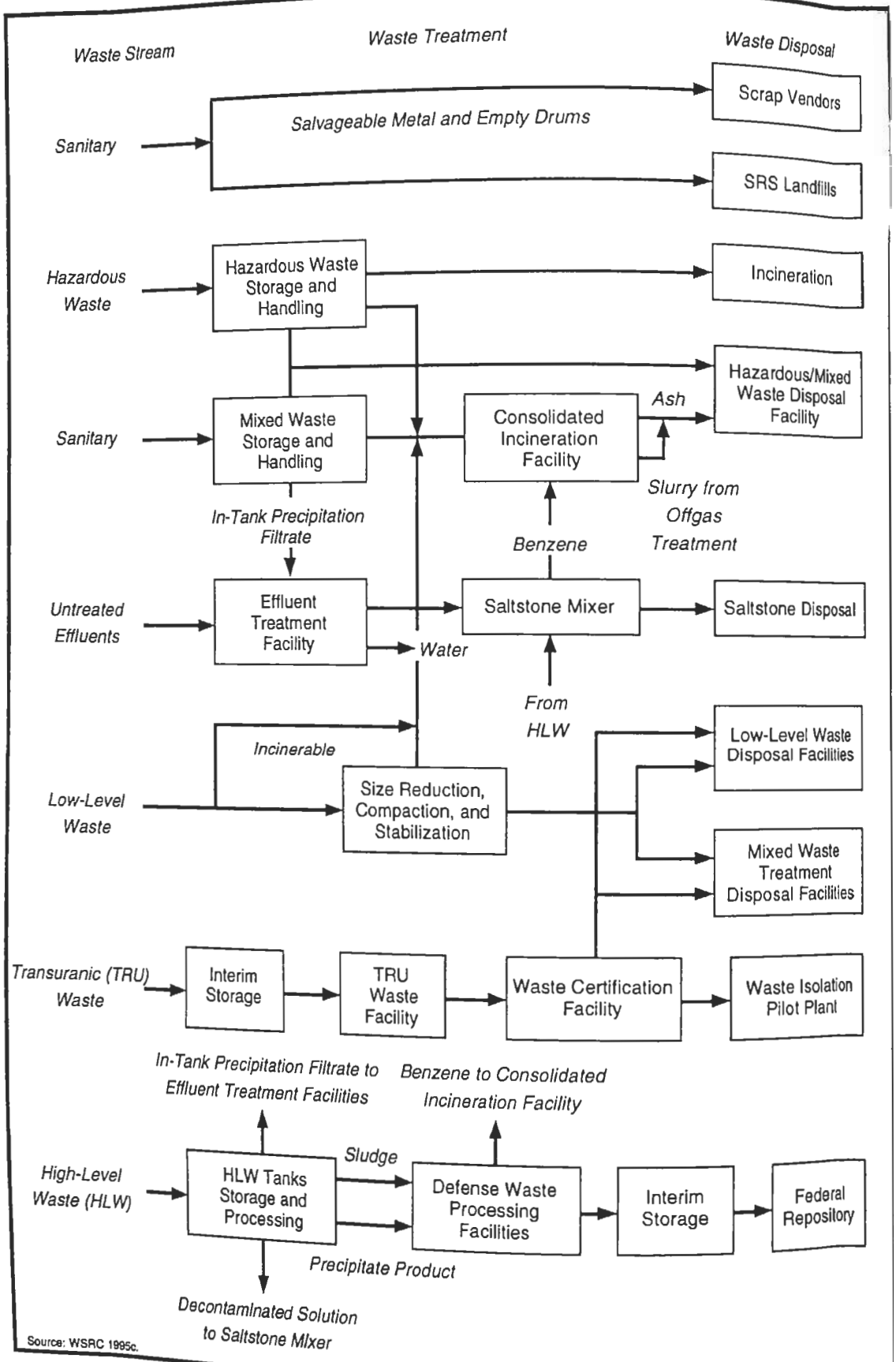

FIGURE A.3.3.2–3.—*Waste System at Savannah River Site.*

pursuant to the requirements of 40 CFR 191 and 40 CFR 268. Noncertifiable drums would be repackaged and certified for shipment to WIPP in the future TRU waste facility.

Mixed TRU waste consisting of leaded gloves and TRU waste contaminated with organics such as solvents would be managed in accordance with the SRS site treatment plan. Current plans call for disposal at WIPP.

Low-Level Waste. Solid LLW would consist primarily of failed equipment and combustible plastics and cellulose-based products used in maintaining and cleaning the facilities. Combustible LLW may be incinerated using the consolidated incineration facility. Solid LLW would be packaged in B-25 (90 ft^3) metal boxes and transported to the LLW disposal facility for disposal in concrete vaults. Evaporator overheads from the evaporation of the high-specific liquid waste described above and other liquid LLW would be sent to the F/H-Area Effluent Treatment Facility where radionuclide contaminants are removed using filtration, ion exchange, and reverse osmosis. The decontaminated effluent would be discharged through a permitted NPDES outfall. Concentrate from the F/H-Area Effluent Treatment Facility is transferred through the H-Area Tank Farm to Z-Area for solidification and final disposal in onsite vaults in Z-Area as a cement-based waste form called saltstone.

Mixed Low-Level Waste. The Pit Fabrication Facility is not expected to generate any mixed LLW. In the event any mixed LLW is generated, it would be managed in accordance with the SRS site treatment plan.

Hazardous Waste. Liquid hazardous wastes would be generated from solvents from cleaning operations and residue from painting and bonding operations. The cleaning solvents selected would be from a list of nonhalogenated solvents. Hazardous wastes would be collected in DOT-approved containers and sent to onsite hazardous waste accumulation areas (B-, M- and N-Areas). The hazardous waste accumulation area would provide a 90-day staging capacity. Incinerable waste would be shipped to an offsite vendor for treatment and disposal. Waste that cannot be incinerated would be placed in storage until the hazardous/mixed waste disposal facility and consolidated incineration facility are operational.

Nonhazardous (Sanitary) Waste. Sewage wastewater would be treated in the new central sanitary wastewater treatment facility prior to discharge through permitted NPDES outfalls. The sludge would be disposed of in a permitted landfill. Other nonrecyclable, nonhazardous, solid sanitary, and industrial wastes would be compacted and disposed of in a permitted landfill.

A.3.4 Nonintrusive Modification Pit Reuse

Unlike the pit fabrication and intrusive modification pit reuse function, the nonintrusive modification pit reuse function does not disassemble the pit. The entire pit is received through the weapons retirement/disassembly process. The pit is then cleaned and inspected, and, if necessary, the exterior of the pit is modified. No plutonium would be exposed in the nonintrusive modification pit reuse function. Since the intrusive modification pit reuse mission described in section A.3.3.1 for LANL and section A.3.3.2 for SRS inherently includes the nonintrusive modification pit reuse capability, a full discussion of the facilities and processes for conducting nonintrusive modification pit reuse activities at LANL and SRS is not included in this section. The nonintrusive modification pit reuse mission at Pantex and NTS are described in sections A.3.4.3 and A.3.4.4.

A.3.4.1 *Los Alamos National Laboratory*

The facilities necessary to accomplish these functions at LANL are a subset of those used in the intrusive modification pit reuse function and are discussed in section A.3.3.1.

A.3.4.2 *Savannah River Site*

The facilities necessary to accomplish these functions at SRS are a subset of those used in the intrusive modification pit reuse function and are discussed in section A.3.3.2.

A.3.4.3 *Pantex Plant*

Pits that are to be reused would be obtained from the weapons A/D Facility that is currently located at

Pantex. Pits would be transferred from one facility to another on the same site, and all infrastructure would be shared. Since the plutonium is encapsulated and any modification is made to the outside of the pit, the entire nonintrusive modification pit reuse process can be conducted in an area that will remain free of radioactive contamination. Three classes of nonintrusive modification pit reuse are proposed at Pantex: recertification (minimum requirement for those pits still within their original design life), requalification (more extensive requirement for those pits that have exceeded their original design life), and nonintrusive modification reuse (modifications imposed upon the pit due to design changes). Pantex would have the capability to recertify 120 pits per year with an annual surge, multi-shift capacity of 200 pits. The combined capability for requalified and modified reused pits would be 150 annually, with a surge annual capacity of 250 pits; of these numbers, approximately 20 pits would be modified. Normal operation is considered to be four 10-hour work days per week, 52 weeks per year.

The facilities that would be used to support the pit recertification, requalification, and nonintrusive modification reuse mission include the weapons assembly bays in Buildings 12-64, 12-84, 12-104, and 12-104A and the current support areas in Zone 12 North along with the special nuclear material facility, Building 12-116. Four existing A/D bays in Building 12-104 would be modified to meet the nonreactor nuclear facility requirements. These four bays, along with an area for control, decontamination, and access control portals, would become the Nonintrusive Modification Pit Reuse Facility. The Nonintrusive Modification Pit Reuse Facility and special nuclear materials facility would be used to consolidate the interim storage, staging, and operations that would be necessary to support recertification, requalification, and nonintrusive modification pit reuse activities.

The Nonintrusive Modification Pit Reuse Facility would make extensive use of robotics. The first area would be used for unpacking and receiving to prepare the pit for the reuse process. As the process starts, the pit would enter the qualification bay and an automated processing line. This line would clean, inspect, and verify tolerances and performance to the specified requirements. The pit would then enter the assembly and welding bay, which includes a glove box line for any needed pit modification. After inspection, the pit would go to the purge and backf bay to be leak tested and cleaned.

The recertification, requalification, and nonintrusi modification reuse processes would generate LL hazardous, industrial, and potentially mixed waste The operating areas would have accumulation sit and would perform the onsite characterization. Th Waste Operations Group would be responsible f establishing the waste streams, scheduling the was movement from the accumulation sites to the was packaging areas, and disposing of the wastes. Thes processes are not intended to generate radioactiv contamination and would not generate TRU or mixe waste under normal operations.

A.3.4.4 *Nevada Test Site*

NTS is an alternative site for the proposed Nonintru sive Modification Pit Reuse Facility. This facilit would require a new building, but it would b adjacent and connected to the Device Assembly Facility. It would be within the secure area of th Device Assembly Facility and would be considered a nonreactor nuclear facility handling special nuclea materials. Though new construction would b required, the existing NTS infrastructure would b sufficient to support the facility. The pits to be reuse in this facility would come from the weapons A/D Facility. Locating the Nonintrusive Modification Pi Reuse Facility at NTS assumes that the new weapons A/D Facility would also be at NTS. The A/D Facility mission would be performed within the Device Assembly Facility (originally designed to support assembly of test devices) and the pits would be transferred through corridors between these facilities. Since the plutonium would be encapsulated and any modification would be made to the outside of the pit, the entire process can be conducted in an area which will remain free of radioactive contamination. Three classes of pit reuse are proposed at NTS: recertification (minimum requirement for those pits still within their original design life), requalification (more extensive requirement for those pits that have exceeded their original design life), and nonintrusive modification reuse (modifications imposed upon the pit due to design changes). The total nonintrusive modification pit reuse capability at NTS for these three classes is 50 pits per year, which is based upon one full shift per day (maintenance and training included in the same shift).

The new Nonintrusive Modification Pit Reuse Facility would use the same processes as proposed for use at Pantex. The basic services required would include radiography, interim storage, gas analysis, gas preparation, and security. Radiography would be accomplished by a linear accelerator that is a shared resource with the A/D Facility. An interim storage area for 50 pits would be planned for within the 2,230 m^2 (24,000 ft^2) new Nonintrusive Modification Pit Reuse Facility. Both the gas analysis and preparation services would be incorporated within the facility. Gas analyses would be used to evaluate samples from accelerated aging tests, material compatibility tests, development activities, material certification tests, and production operations. Security in and around the Device Assembly Facility is sufficient (though it would be expanded) for the new facility, and the shipping and receiving functions would be handled through the Device Assembly Facility. The waste streams and utility requirements would be considered a part of the A/D process and are included with that estimate (see section A.3.1.2). The processes would include a waste management facility, waste storage facility, mixed waste storage and LLW disposal facility, sanitary wastewater treatment unit, sanitary and industrial landfill, and stormwater ponds.

A.3.5 High Explosives Fabrication

The HE fabrication mission requires explosives synthesis, formulation, pressing, machining, testing, evaluation, and component manufacturing. In addition to these fundamental capabilities, a variety of support activities is required.

The explosives fabrication activity is important to the overall mission of the future DOE Complex. Over the past several years, economic trends have dictated a significant reduction in the domestic commercial support for this technology. In today's marketplace it is difficult to secure the small quantities of products necessary to sustain the reduced workload from commercial sources. The meticulous quality required of the explosives and components placed in nuclear weapons also disqualifies most commercial vendors.

Assumptions. In addition to the general assumptions used in preparing this PEIS, the following assumptions apply specifically to the HE fabrication mission:

- Baseline technologies will be used except where alternatives can be shown to meet requirements and be more cost effective.
- All production operations can be housed in existing facilities.
- Raw materials required to manufacture explosive charges are available either from within DOE or from commercial manufacturers.

General Functions and Layout. The general functions of HE fabrication are HE main charge manufacturing, small HE component manufacturing, HE formulation and synthesis, and HE testing and characterization. Production support functions include storage of raw materials and staging, packaging, and shipping of the intermediate and final product. These functions convert commercially available raw materials into HE and related components for weapons. These general functions also provide for testing and safe handling and storage of both raw materials and in-process and finished products.

The facilities required to perform HE fabrication functions can be arranged in a variety of layouts to accommodate existing structures. Structures co taining explosives operations are generally co structed with steel-reinforced concrete and a designed to mitigate the effects of an acciden explosion. Although insensitive HE materials c generally be processed in conventional steel str tures, concrete construction is typically used maintain the flexibility to process convention explosives. The resulting facility design typical consists of a number of separate operating bays th could vent to an unoccupied area should a detonati occur. Structures that do not require concrete co struction due to a lack of HE presence are general constructed of steel, although portions of thes buildings may be concrete. Most facilities includ support areas for offices, break rooms, rest room electrical equipment, heating, ventilation, and a conditioning equipment, maintenance, and in process staging of materials, components, tooling and supplies. Many production and laboratory facil ities also include vacuum systems. Utilities require include water, steam, compressed air, and electricity

High Explosives Main Charge Manufacturing. Thi function manufactures main charge explosive subas semblies, main charge mock explosive assemblies and explosive test specimens. An area must also be provided for conducting physical property testing of explosive components and materials. Each subfunction is described below.

High Explosives Pressings. Rough shapes for HE main charge subassemblies and material test billets are manufactured by pressing. These presses also produce rough shapes for mock components from nonexplosive materials. Sufficient area is needed to include presses, ovens, powder inspection tables, loading tables, and shadowgraph equipment.

Explosives Machining. The rough pressings are machined into hemispherical shapes or test elements using a combination of mills and lathes. HE machining is conducted wet, and a recirculating water treatment system is provided. Mock components may be machined in the same area or in the machine shop. Sufficient area is needed to include equipment for conducting density measurements, dye penetrant testing, and dimensional inspection.

Main Charge Subassembly. The explosive hemispheres are assembled with electrical parts and

hardware to produce main charge subassemblies. This is a manual operation that generally involves potting and bonding.

Mechanical Properties Testing. The physical properties of explosive components and materials are tested to support War Reserve lot certification for materials and components and to support production development. The test configurations are assembled and tensile, torsion, and compression tests are conducted.

Small High Explosives Component Fabrication. This process fabricates small HE weapon components and test assemblies. Various small components are fabricated from HE powders and binders, metal or plastic components, electrical components, hardware, and assembly materials. The fabrication process requires equipment for explosive powder heating, pellet pressing, laser welding, ultrasonic cleaning, extrusion loading, density testing, and mechanical assembly. Functions are described below.

Pellet Pressing. Small pellets are pressed to density specifications from small energetic components assemblies.

Extrusion Loading. Extrudable (paste) explosive is loaded onto small fixtures for small component assemblies.

Small Component Assembly. Small HE pellets and/or fixtures containing extrudable paste explosives are assembled with inert parts to make small components.

High Explosives Formulation and Synthesis. This process produces a variety of explosive materials from chemical reactants and commercially produced explosives.

High Explosives Formulation. This function produces a variety of explosive materials from chemical reactants and commercially produced explosives. Material lots up to about 91 kg (200 lb) are produced through a series of batch operations. Some products are used to make small HE weapon components, while other products support the development of new explosives or explosives manufacturing processes.

High Explosives Synthesis. The synthesis process integrates a variety of vessels, filters, and transfer pumps which are used to synthesize, recrystallize, blend, and wash explosive powders. The facility includes bays for mixing/milling, particle-size reduction, drying/weighing/packaging, solvent storage, and refrigerated storage for explosives and chemicals.

High Explosives Testing and Characterization. Explosives test configurations are assembled and then detonated. The test data characterize the explosives performance and are required for the qualification of raw materials and production lots. Testing requires explosives containment chambers and an array of special instrumentation including streak cameras, rotating mirror framing cameras, an air image converter system, oscilloscopes and digitizers, flash x-ray systems, and velocity interferometers.

High Explosives Test Firing. Energetic materials components are test fired at a remote firing facility which includes an outdoor firing capability to conduct large-scale explosives tests that cannot be performed in a test chamber, such as main charges for explosives lot certification.

Nondestructive Evaluation. Explosive components are inspected using neutron radiography, x-ray, magnetic particle, and eddy current equipment to detect flaws, cracks, and voids in explosive and inert components.

Mechanical Properties Testing. The mechanical properties of explosive components and materials are tested to support lot certification for materials and components and to support fabrication development. The test configurations are assembled and tensile and comprehensive tests are conducted.

Analytical Laboratory. Chemical analyses are performed on explosive and nonexplosive materials to determine or verify their characteristics. The data obtained yield valuable information about the condition and composition of the material. This information is used to assure reliability of components and to statistically evaluate performance with material characteristics. The methods used include gas chromatography, liquid chromatography, size exclusion chromatography, infrared spectroscopy, thermal analysis, particle characterization, atomic

spectroscopy, and emission spectroscopy. Surface chemistry, metallography, optical and scanning electron microscopy, and wet chemistry are also performed.

Material Compatibility Testing. Test coupons are assembled such that the subject materials are in direct contact with each other. These coupons are then placed in environmental ovens to accelerate the aging process. Gas samples are periodically taken from the coupon containers and analyzed by the gas laboratory. Compatibility testing is required to certify new materials for weapon use.

Production Support. The following functions and facilities are needed to support the HE fabrication missions.

Bulk Explosives Storage. This function requires facilities to store collectively 31,800 kg (70,000 lb) of conventional HE powders awaiting transfer to/from the HE staging facility and offsite explosives vendors. These materials are typically received in 4,500 to 9,000 kg (10,000 to 20,000 lb) lots. Storage facilities also are needed for storing 182,000 kg (400,000 lb) of insensitive HE that is awaiting transfer to and from the explosive staging facilities. The bulk explosives facilities would be designed to provide separation between incompatible explosives types and would be remotely located from the production operations.

Explosives Staging/Packaging/Shipping. This function would require staging a variety of explosive powders, components, and assemblies for supporting HE operations. These explosive materials include plastic bonded explosives for main charge manufacturing, completed main charges, small HE components, energetic feeds and products for HE formulation and synthesis, and explosive residues for disposal or recycling. The staging facilities would be designed to provide separation between incompatible explosives types.

Process Support Systems. Process support for the HE manufacturing operation would include a machine shop and ES&H laboratory as well as other plant general services facilities. These facilities would directly support the HE fabrication mission as well as RD&T and other activities.

Facility Utilities. HE fabrication utility requirements are a function of the size, condition, and location of the facilities as well as the production requirements. Therefore, the utility requirements vary at each of the three candidate sites. Utilities are described in subsequent sections for each candidate site. A typical water balance for HE fabrication is shown in figure A.3.5–1.

Chemicals Required. The chemicals and materials consumed during operation primarily include water treating chemicals, reactants and solvents for explosives formulation and synthesis, explosives powders, materials for facility equipment and vehicle maintenance, and bottled gases. Specific lists of chemicals used by each site are provided under the site alternative description.

The HE fabrication process also requires the following chemical support materials:

- Solvents and wipes for manual cleaning operations
- Adhesives and bonding agents for manual assembly operations
- Glycerin fluid for preparing the isostatic pressing fluid
- Release agents for coating the inside of mechanical die sets used in pressing operations
- Dye for the penetrant test
- Shipping and packaging materials
- X-ray film
- Bottled nitrogen for extrusion loading
- Bottled argon for laser welding
- Solvents and feedstocks for the synthesis of hexanitrostilbene and triaminotrinitrobenzene powders
- Other miscellaneous materials required for routine operations

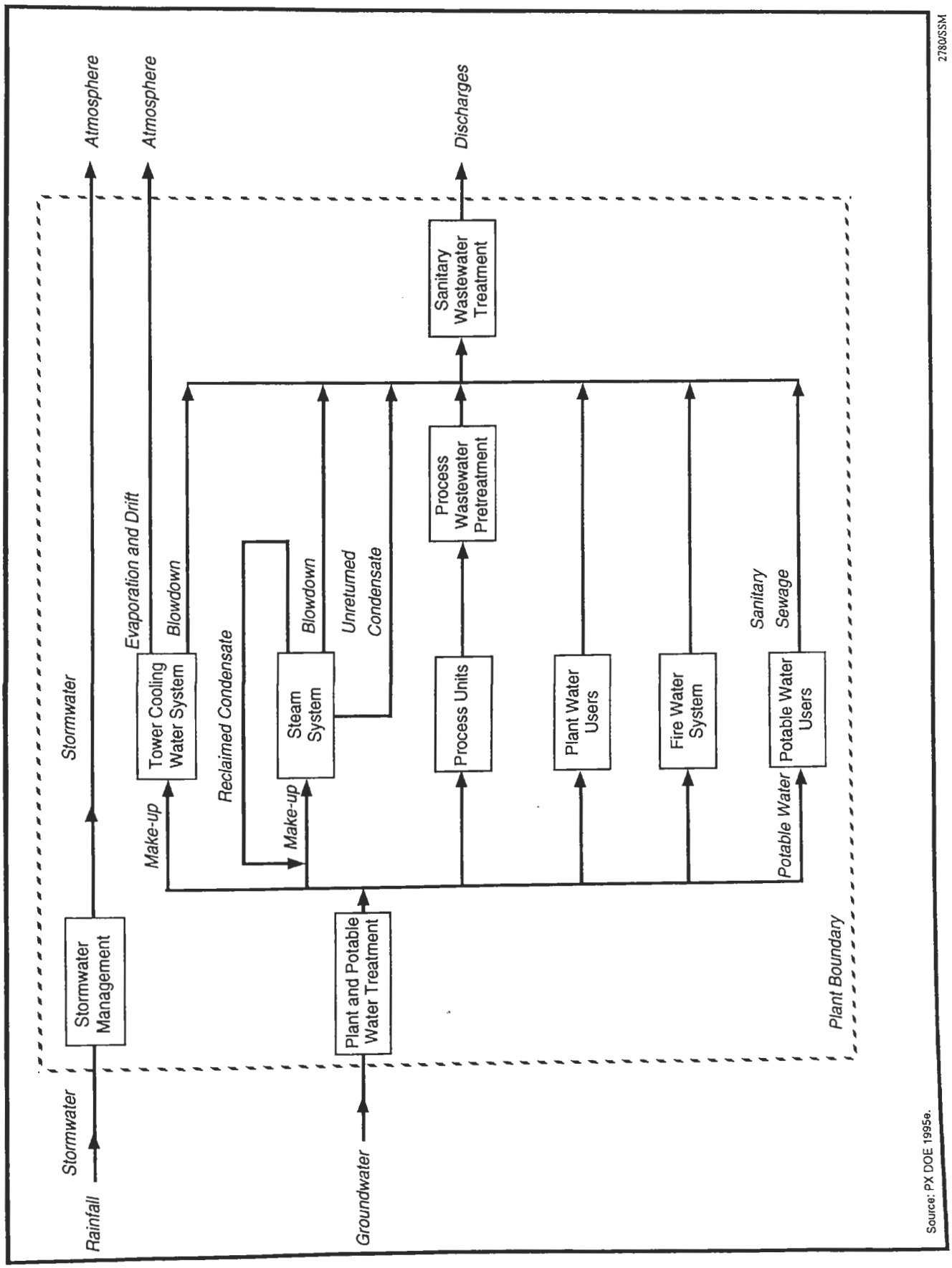

FIGURE A.3.5–1.—*High Explosives Fabrication Annual Water Balance.*

Transportation

Intersite Transportation. The HE shipping/receiving facility would be designed to ship and receive bulk HE materials to and from the HE plant. These materials typically would be received in 4,500 to 9,000 kg (10,000 to 20,000 lb) lots.

Shipping of completed charges would follow appropriate HE shipping regulations. All hazardous chemicals would be shipped using appropriate DOT requirements. The major type of hazardous material that would be transported to the plant would be HE materials. Bulk explosives powders would be delivered to the site by DOT-approved bulk commercial carriers. The powder would be unloaded at the bulk explosives storage facilities, which would isolate it from other facilities on the site.

Intrasite Transportation. All intrasite transportation required for manufacture would occur within existing site boundaries and would not require use of public roads. Appropriate HE shipping regulations as defined by DOE and DOT would be followed. Shipment of HE components for testing may require the use of public roads. After testing and manufacturing, subsequent movements of HE and explosive components would be performed by trucks and battery-powered vehicles specifically designed for this purpose. The quantity of HE (conventional and insensitive) transported onsite by these trucks would be strictly limited.

Explosives main charges and components would be transferred to staging areas while awaiting transfer to the A/D plant. In a similar manner, explosive components from the A/D plant would be transferred to the explosives production plant for demilitarization, sanitization, and disposition. Small quantities of hazardous wastes generated during operations would be collected, packaged, and transported by electric car to local accumulation sites and then by truck to a staging area. The waste would be transferred by truck for offsite disposal.

Waste Management. The HE fabrication process generates the following waste and residual materials:

- Bulk HE machining scrap
- Off-specification HE components
- HE-contaminated materials, such as gloves and wipes, from manual cleaning operations
- Glycerin pressing fluid
- Developing materials from x-ray and neutron radiography film processing
- Hazardous contaminated materials from chemical bonding operations, packaging/repackaging, storage/staging, and shipment for ultimate disposal

The waste management process for HE fabrication at the alternative sites follows in sections A.3.5.1 through A.3.5.3.

A.3.5.1 *Downsize at Pantex Plant*

Pantex is the current DOE site for HE main charge manufacturing, small HE component manufacturing, HE formulation and synthesis, and HE testing and characterization. To efficiently meet the expected Complex workload, Pantex can downsize current HE fabrication operations. The following description assumes a downsized HE production mission at Pantex along with the A/D functions.

Significant downsizing actions at Pantex focus on functional consolidation. This can be achieved by reducing the number of facilities operating in the explosives area to 11 or 12 and decreasing the direct, direct support, and direct operations support personnel to about 50. There are no processes to be transferred from offsite. All facilities identified under this plan meet Federal regulations and DOE orders as they pertain to explosives manufacturing. Table A.3.5.1–1 indicates specific products and capabilities that comprise the HE fabrication mission at Pantex.

Assumptions. Requirements are based on an annual production rate of 150 replacements or retrofits. The 150 replacements or retrofits consist of 100 warheads and 50 bombs. The capability of providing explosives for two weapons systems in any given year is maintained. The Stockpile Evaluation Program consists of 120 disassemblies and inspections, 110 rebuilds, and additional joint test assemblies, joint test assembly post mortems, and test beds consistent

TABLE A.3.5.1–1.—*Pantex Plant High Explosives Fabrication Products and Capabilities*

Products	Capabilities
High Explosives	**Manufacturing Process Development**
	Stockpile stewardship support
	Formulation
	Synthesis
	Surveillance
Binders	**Main Charge Manufacturing**
	Pressing
	Machining
	Subassembly
	Receiving/storage
	QA-mechanical/chemical/test fire
	Disposition
Main Charge Formulations	**Energetic Component Manufacturing**
	Pressing
	Machining
	Subassembly
	Receiving/storage
	QA-mechanical/chemical/test fire
Initiation High Explosives	**Detonators**
Mock High Explosives Formulations	**Testing**

Note: QA - quality assurance.
Source: PX DOE 1995e.

with current guidance and stockpile levels. Some existing programs in the enduring stockpile use main charges made from conventional HE. Insensitive HE machining and storage continue to be explosive hazard Class IV operations. All hexanitrostilbene-based explosives and micronized-triaminotrinitrobenzene materials required would be produced at the HE production plant. Spare equipment and facilities are not included in the minimum facility requirements.

Facility and equipment maintenance would occur on the off-shift and the nonwork days when feasible. The Complex would be capable of producing materials and assembling replacement components and units for two weapon systems in any given year. This capability would be achieved by either simultaneous or sequential campaigns, as long as the sum of the product shipments for the year meets the annual production goals. The stockpile stewardship and management alternatives would not impact the ongoing plant missions, either during construction or during the life of the upgraded plant. Ongoing plant missions are defined as those functions performed today.

Strategic reserve requirements for explosives would be stored at the HE production site. The selected site for the HE production mission would be operational within 2 years after the ROD for this PEIS. The baseline technology for HE production comprises the present techniques utilized at Pantex. If transferred, prebuilds at the donor site would fill any production capability gap between the donor and receiver site for the HE operations. If HE production missions are transferred, a 5-year period is required to accomplish the D&D activities at Pantex.

Facility Description. As stated previously, there would be no product or process transfers; however, there would be substantial functional consolidation. For example, Pantex currently has seven functional test fire sites. All test activities identified as required to support the enduring stockpile can be consolidated into two sites: a fully contained indoor test chamber and an outdoor site to accommodate large charges. Explosives components fabrication would be reduced from four buildings to two. Chemical characterization, nondestructive evaluation, and mechanical testing would be consolidated from the current five facilities to two, as well. A comprehensive listing of the planned consolidations can be found in table A.3.5.1–2. Figures A.3.5.1–1, A.3.5.1–2, and A.3.5.1–3 show the locations of the zones and the facilities within these zones.

Pantex consists of 425 buildings containing approximately 232,300 m^2 (2.5 million ft^2) of floor space of which explosives operations occupy 37,200 m^2 (400,000 ft^2). Within 4,119 ha (10,177 acres), approximately 809 ha (2,000 acres) are dedicated to active facility operations. Approximately 3,270 ha (8,080 acres) are devoted to storage, disposal, and miscellaneous activities in support of plant operations.

TABLE A.3.5.1-2.—*Pantex Plant Functional Consolidation of Explosives Operations*

Capabilities	Current Facilities	Consolidated Facilities (Projected)
Synthesis	11-36	11-55
Formulation	12-19E, 12-62	11-50, 12-62
Isostatic pressing	12-63	12-63
Explosives machining	11-50, 12-121	12-121
Explosives subassembly	12-31	12-121
Explosives components	11-20, 12-17, 12-62, 12-63	12-62, 12-63
Evaluation/characterization	11-5, 11-17, 11-51, 12-21, 12-59	11-51, 12-104A
Test fire	11-18, 11-38, FS-10, FS-11, FS-21, FS-22, FS-24	FS-11, FS-22, FS-24
Explosives storage	11-42, 12-65, 12-83, Zone 4 (8 magazines)	12-65, Zone 4 (4 magazines)
Explosives disposal	Burning Ground	Burning Ground

Source: PX DOE 1995e.

Pantex structures containing explosives operations comply with the *DOE Explosives Safety Manual,* DOE/EV/06194 and are generally constructed with steel-reinforced concrete and designed to mitigate the effects of an accidental explosion. Although insensitive HE materials can generally be processed in conventional steel structures, concrete construction is typically used to maintain the flexibility to process conventional explosives. The resulting facility design typically consists of a number of separate operating bays with remote and/or contact operating capability that are fully contained or could vent to an unoccupied area should a detonation occur. Most facilities include support areas for offices, break rooms, rest rooms, electrical equipment, heating, ventilation, and air conditioning equipment, maintenance, and in-process staging of materials, components, tooling, and supplies. Many production and laboratory facilities also include vacuum systems. Utilities required include steam, compressed air, and electricity.

The HE facilities are primarily within the Applied Technology Division. These facilities would support main charge manufacturing, small component manufacturing, formulation and synthesis, and explosives testing and characterization, as well as HE storage and disposition.

Design Safety. The following sections identify important safety considerations incorporated in the design of explosives facilities. Performance goals commensurate with the associated hazard are selected for all structures, systems, and components. The term "hazard" is defined as a source of danger, wheth external or internal. Natural phenomena such earthquakes, extreme winds, tornadoes, and floo are external hazards to structures, systems, and co ponents; whereas toxic, reactive, explosive, radioactive materials contained within the facili are internal hazards. Usage category is establish by DOE management. Guidelines for usa category (performance category) and the corr sponding performance goals are given in *Design Evaluation Guidelines for DOE Facilities Subject to Natural Phenomena Hazards* (UCRL-15910).

Earthquakes. All existing facilities meet th standards as cited below. Structures, systems, an components are designed for earthquake-generate ground accelerations in accordance with Universit of California Research Laboratory (UCRL)-1591(The applicable seismic hazard exceedance prob bility is $2x10^{-3}$ for general use (performanc category 1), $1x10^{-3}$ for low and moderate hazar (performance categories 2 and 3), and $2x10^{-4}$ fo high hazard (performance category 4) for struc tures, systems, and components.

Seismic design considerations for performanc category 3 and 4 structures, systems, and compo nents include provisions for such structures systems, and components to function as hazardou materials confinement barriers and for adequat anchorage of building contents to prevent loss o critical function during an earthquake. In essence design considerations are to avoid premature, unex-

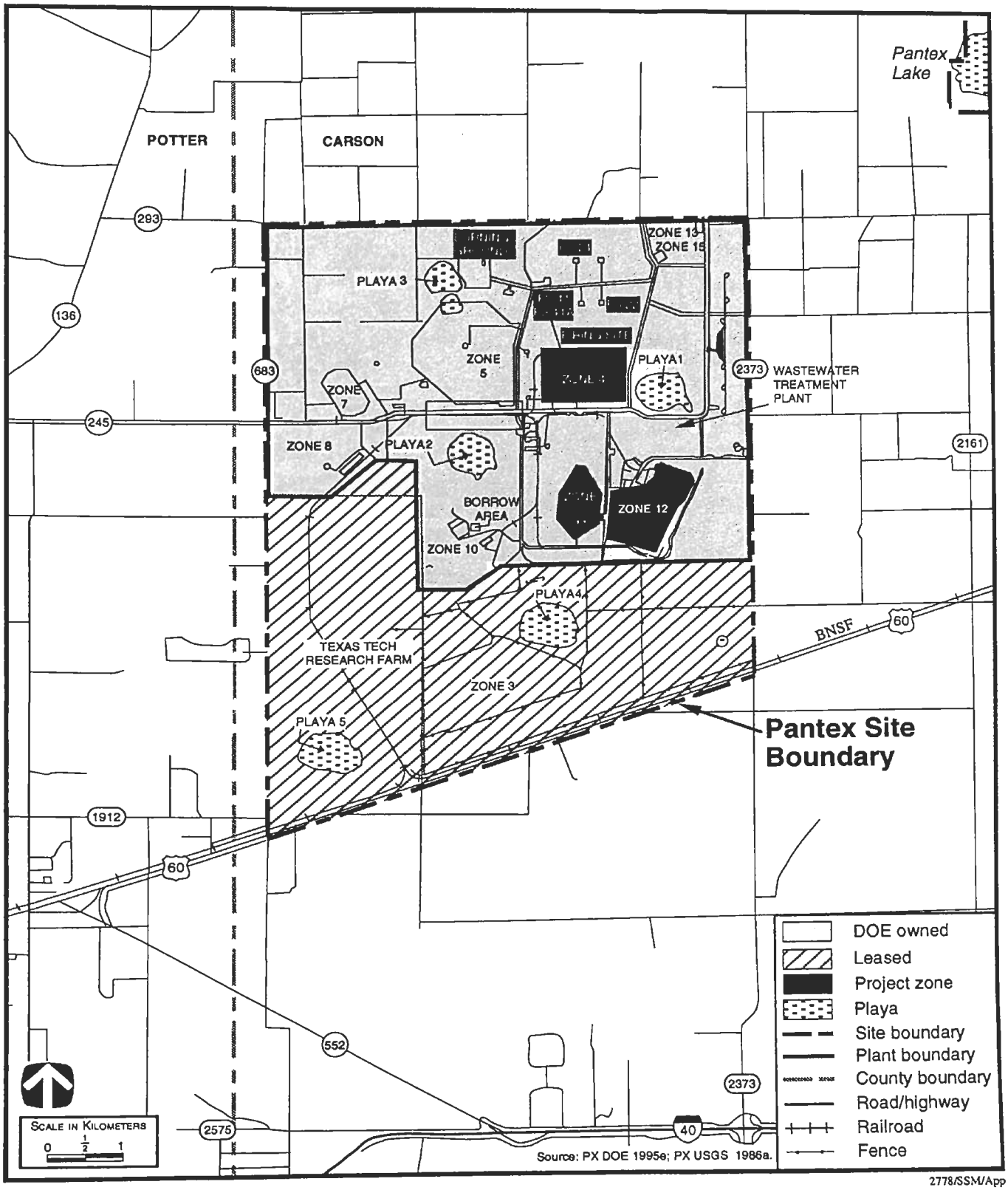

FIGURE A.3.5.1–1.—***High Explosives Fabrication Alternative Locations at Pantex Plant.***

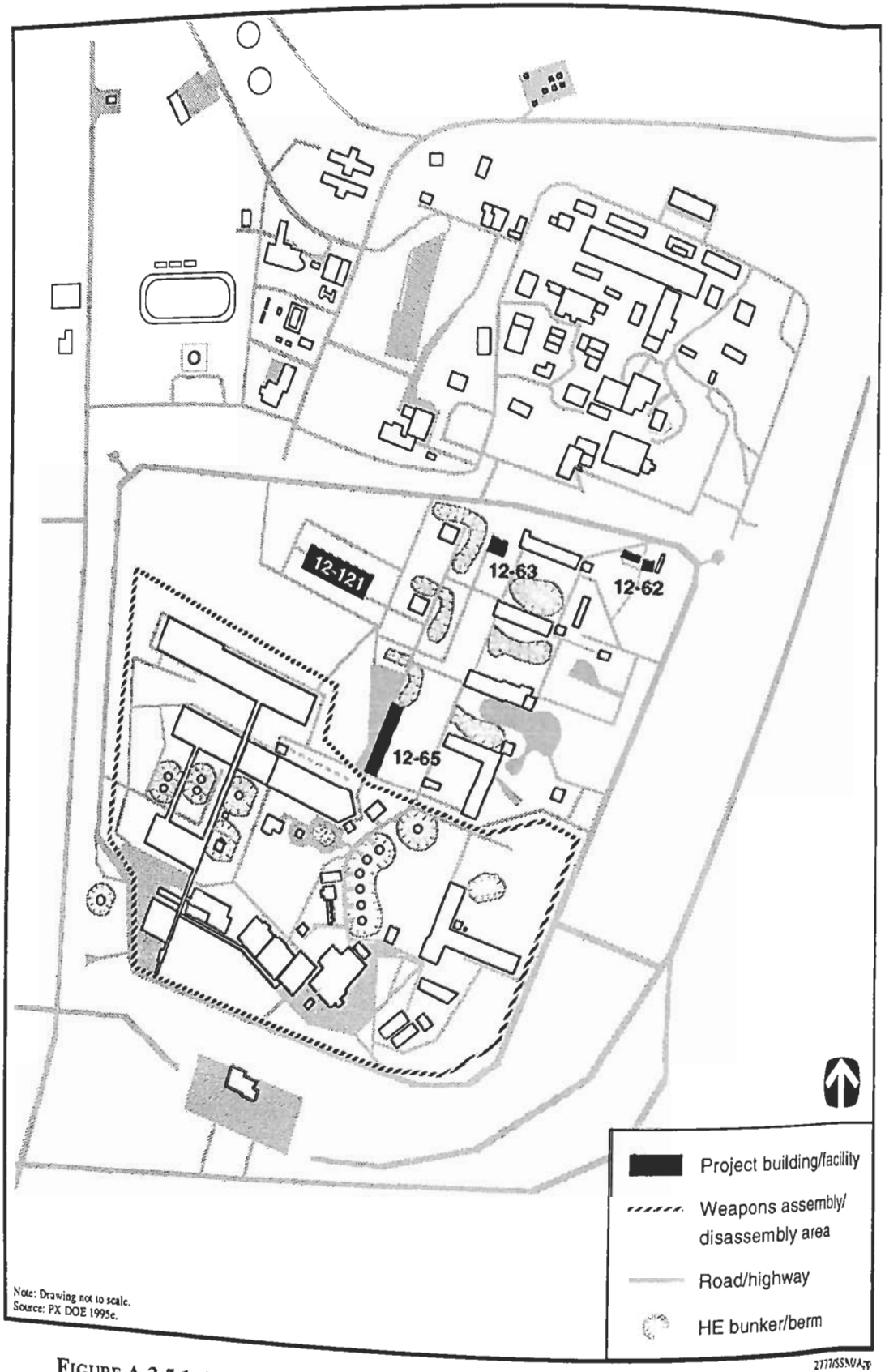

FIGURE A.3.5.1-2.—*High Explosives Fabrication Alternative Facilities Within Zone 12 at Pantex Plant.*

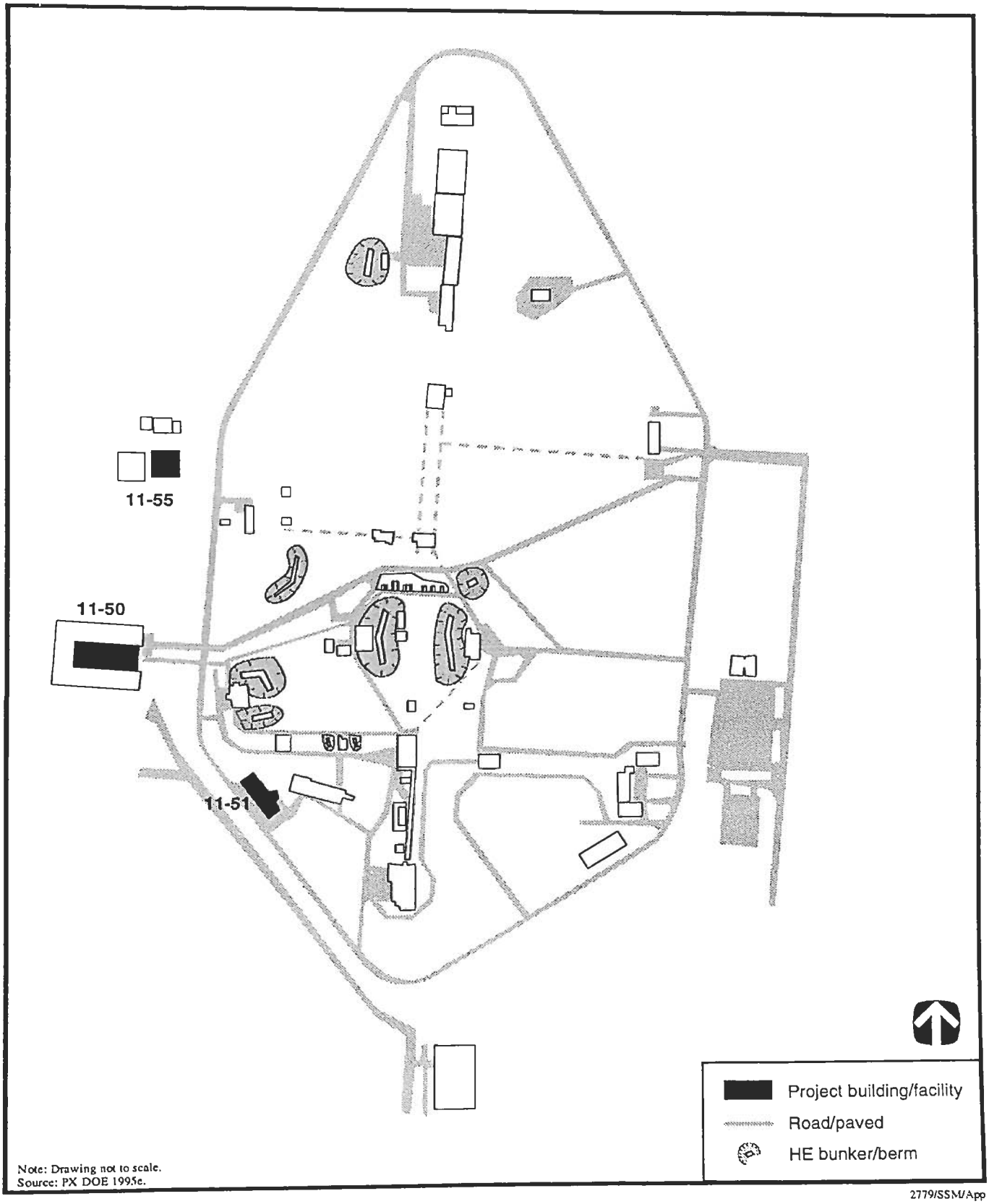

FIGURE A.3.5.1–3.—*High Explosives Fabrication Alternative Facilities Within Zone 11 at Pantex Plant.*

pected loss of function, and to maintain ductile behavior during earthquakes.

The fire protection system, emergency power, water supplies, and controls for the safety class equipment are some of the necessary emergency items that must be available following an earthquake. As stated in UCRL-15910, earthquake-resistant design considerations extend beyond the dynamic response of structures and equipment to include survival of systems that prevent facility damage or destruction due to fires or explosions.

Wind. All existing plant structures, systems, and components at Pantex meet the wind or tornado load criteria and the corresponding facility usage and performance goals. Wind design criteria are based on annual probability of exceedance, importance factor, missile criteria, and atmospheric pressure changes as applicable to each performance (usage) category as specified in UCRL-15910. Wind loads are based on the annual probability of exceedance of $2x10^{-2}$ for the general and low hazard (performance categories 1 and 2), $1x10^{-3}$ for the moderate hazard (performance category 3), and $1x10^{-4}$ for the high hazard (performance category 4) structures, systems, and components. Since tornadoes are the viable wind hazards, structures are designed for the annual probability of exceedance of $2x10^{-5}$ as defined in UCRL-15910.

Floods. All facilities required for the HE operations at Pantex are located above the critical flood evaluation. The extent of the flood hazard is determined using the appropriate usage (performance) category for determining the "Annual Hazard Probability of Exceedance": $2x10^{-3}$ for the general use (performance category 1), $5x10^{-4}$ for the important or low hazard (performance category 2), $1x10^{-4}$ for the moderate hazard (performance category 3), and $1x10^{-5}$ for the high hazard (performance category 4) facility as defined in UCRL-15910.

Whenever possible, all facilities in performance categories above the general use category (performance category 1) are constructed with the lowest floor of the structure, including subsurface floors, above the level of the 500-year flood. This requirement can be met by siting and/or flood protection. Whenever possible, all facilities, including their basements, all performance categories are sited above the 1(year floodplain.

Fire Protection. The fire protection features for plant and its associated support buildings are accordance with DOE orders and the National F Prevention Association Fire Codes and Standar Redundant firewater supplies and pumping capab ties are installed to supply the automatic and ma fire protection systems located throughout the s Appropriate types of fire protection systems a installed to provide life safety, prevent large-l fires, prevent production delay, ensure that fire d not cause an unacceptable onsite or offsite release hazardous material that will threaten the pub health and safety of the environment, and minim the potential for the occurrence of a fire and rel perils. Specific production areas and/or equipm are provided with the appropriate fire detection a suppression features, as required, with respect to t unique hazard characteristics of the product proc

Safety Class Instrumentation and Control. T safety classification of instrumentation and cont are derived from the safety functions which th perform. The safety classification is based on ap priate DOE orders. Existing facilities at Pantex m all safety class requirements. Safety instrumentati is designed to monitor identified safety-relat variables in safety class systems and equipment o expected ranges for normal operation, accident co ditions, and safe shutdown. Safety class controls a provided when required to control these variabl Safety class instrumentation is designed to fail in safe mode following a component or channel failu Safety class Uninterruptable Power Supply power provided when appropriate.

Ventilation. The heating, ventilation, and air con tioning system design of existing facilities meets general design requirements in accordance with DO orders, and American Society of Heating, Refriger ing, and Air Conditioning Engineers guides. T design includes engineered safety features to prev or mitigate the potential consequences of postulat design basis accident events.

Internal Explosion. Buildings containing HE are designed to mitigate the effects of accidental explosion within a bay or cell. The design is in accordance with the *DOE Explosive Safety Manual*, DOE/EV/06194, including the quantity-distance and the level-of-protection criteria for each class of explosives activities.

Overall Facility Layouts and Design Description. Pantex facilities proposed for the HE fabrication mission are listed in table A.3.5.1–3 and described in this section. The table summarizes key facility data for existing buildings and support areas. Data for the facilities include building number, description, construction type (concrete or steel), gross square meters, number of levels in the structure, and explosives present.

Structures containing explosives operations are generally constructed with steel-reinforced concrete and are designed to mitigate the effects of an accidental explosion. Although insensitive HE materials can generally be processed in conventional steel structures, concrete construction is typically used to maintain the flexibility to process conventional explosives.

The resulting facility design typically consists of a number of separate operating bays that could vent to an unoccupied area should a detonation occur. Structures that do not require concrete construction due to the presence of HE are generally constructed of steel, although portions of these buildings may be concrete. Most facilities include support areas for offices, break rooms, rest rooms, electrical equipment, heating, ventilation, and air conditioning equipment, maintenance, and in-process staging of materials, components, tooling, and supplies. Many production and laboratory facilities also include vacuum systems. Utilities required include water, steam, compressed air, and electricity.

High Explosives Main-Charge Manufacturing. These facilities manufacture explosive subassemblies, main charge mock explosive hemispheres, and explosive test specimens. An area is also provided for conducting physical property testing on explosive components and materials. Each functional area is described below.

Isostatic Pressing (Building 12-63). Rough pressings for HE main charge subassemblies and material test billets are manufactured in Building 12-63.

TABLE A.3.5.1–3.—*Pantex Plant High Explosives Fabrication Facility Data*

Facility Function	Building Number	Construction Type	Gross Area (m^2)	Number of Levels	Special Materials
Bulk explosives storage	04-101 - 04-104	Concrete	441	1	HE
Synthesis	11-55	Concrete	279	1	HE
HE formulation	11-50	Concrete	2,062	2	HE
Chemical testing/evaluation	11-51	Concrete	1,078	1	None
HE main charge pressing	12-63	Concrete	223	1	HE
Explosives staging/packaging/shipping	12-65	Concrete	753	1	HE
Fabrication/assembly	12-62, 12-63	Concrete	548	1	HE
Explosives machining/gaging/subassembly/ safety testing/physical testing/ nondestructive evaluation	12-121	Concrete	4,562	1	HE
Test fire assembly	FS-11	Steel	190	1	HE
Outdoor firing site	FS-22	Concrete	167	1	HE
Contained firing site	FS-24	Concrete	701	1	HE
HE disposal	Burning Ground	Concrete	56	1	HE

Source: PX DOE 1995e.

Explosives Machining (Building 12-121). The rough pressings are machined in Building 12-121.

Main Charge Subassembly (Building 12-121). The explosives hemispheres are assembled in Building 12-121.

Mechanical Properties Testing (Building 12-121). The physical properties of explosive components and materials are tested in a portion of Building 12-121.

Small High Explosives Component Manufacturing (Buildings 12-63, 12-121). Various small components are manufactured from HE powders and binders, metal or plastic components, electrical components, hardware, and assembly materials. The manufacturing process requires equipment for explosive powder heating, pellet processing, laser welding, ultrasonic cleaning, extrusion loading, density testing, inspection, and mechanical and electrical assembly.

Test Firing (Buildings FS-11, FS-22, FS-24). Explosives test configurations are assembled and tested at Buildings FS-11, FS-22, and FS-24. The test data characterize the explosives performance and are required for the qualification of raw materials and production lots. Testing requires explosives containment chambers and an array of special instrumentation including streak cameras, rotating mirror framing cameras, digitizers, flash x-ray systems, and velocity interferometers. Outdoor firing sites are used to conduct explosives tests (e.g., skid and hydrodynamic tests greater than 1 kg [2.2 lb]) that cannot be performed in a test chamber. These facilities are remotely located from production operations.

Nondestructive Evaluation (Building 12-121). Explosive components are inspected using neutron radiography, x-ray, magnetic particle, and eddy current equipment to detect flaws, cracks, and voids in explosives and inert components. Nondestructive evaluation also supports the A/D mission.

High Explosives Formulation (Buildings 11-50 and 12-62) and Synthesis (Building 11-55). These facilities have the capability to produce a variety of explosives materials from chemical reactants and commercially produced explosives. Material lots up to about 91 kg (200 lbs) are produced through a series of batch operations. Some products are used to make small HE weapon components, while other products support the development of new explosives or explosives manufacturing processes.

The HE formulation and synthesis facilities include several flexible processing bays that contain a variety of vessels, filters, and transfer pumps used to synthesize, recrystallize, blend, and wash explosive powders. The facilities also include bays for mixing/milling, reducing particle size, drying/weighing/packaging, storing solvent, and refrigerated storing of explosives and chemicals. Building 11-55 replaces the existing synthesis facility (Building 11-36), which is in deteriorating condition. Building 11-50 replaces an existing formulation capability in Building 12-19E.

Production Support. The production support facilities house an analytical laboratory and material compatibility testing.

Analytical Laboratory (Building 11-51). Chemical analyses are performed on explosive and nonexplosive materials in Building 11-51 to determine or verify their characteristics. The data obtained yield valuable information about the condition and composition of the material. This information is used to ensure components' reliability and to statistically evaluate performance with material characteristics. The methods used include gas chromatography, liquid chromatography, size exclusion chromatography, infrared spectroscopy, thermal analysis, particle characterization, atomic spectroscopy, and emission spectroscopy. Surface chemistry, metallography, optical and scanning electron microscopy, and wet chemistry are also performed.

Material Compatibility Testing (Building 11-51). Test coupons are assembled such that the subject materials are in direct contact with each other. These coupons are then placed in environmental ovens to accelerate the aging process. Gas samples are periodically taken from the coupon containers and analyzed by the gas laboratory. Compatibility testing is accomplished in Building 11-51 and is required to certify new materials for weapon use.

Bulk Explosives Storage (Buildings 4-101 through 4-104). These facilities are designed to store collectively 31,800 kg (70,000 lb) of conventional HE powders while awaiting transfer to or from the HE

staging facility and offsite explosives vendors. These materials are typically received in 4,500 to 9,000 kg (10,000 to 20,000 lb) lots. These facilities also are used for storing 182,000 kg (400,000 lb) of HE awaiting transfer to or from the explosives staging facilities. The bulk explosives facilities would be designed to provide separation between incompatible explosives types and would be located remotely from the production operations.

Explosive Staging/Packaging/Shipping (Building 12-65). These facilities are designed to stage a variety of explosives powders, components, and assemblies for supporting HE operations. These explosives materials include plastic bonded explosives for main charge manufacturing, completed main charges, small HE components, energetic feeds and products for HE formulation and synthesis, and explosives residues for disposal or recycling. These facilities are designed to provide separation between incompatible explosives types.

Resource Requirements During Construction/Modification. Requirements during construction and modification to implement the downsized configuration for HE fabrication at Pantex are described below.

Land Area Requirements During Modification. Downsizing in place of the explosives production operations at Pantex requires approximately 0.12 ha (0.3 acres) of land for construction laydown and warehousing and an additional 0.04 ha (0.1 acres) to accommodate construction parking. These activities would occur in previously developed land areas.

Materials and Resources Consumed During Modification. The materials and resources consumed during downsizing of the explosives production operation at Pantex are shown in table A.3.5.1–4. These resources include utilities, construction materials, liquid fuels, and industrial gases.

Emissions During Modification. Air pollutants are emitted during modification activities required for the downsizing of the explosives production operations. The principal sources of such emissions are fugitive dust from site preparation for material laydown areas, other construction activities, and exhaust from construction equipment and vehicles. The estimated annual emissions generated during a 1-year period with peak construction activity are shown in table A.3.5.1–5.

TABLE A.3.5.1–4.—*Pantex Plant High Explosives Downsizing Materials/Resources Requirements*

Material/Resource	Total Consumption	Peak Demand[a]
Electricity	257 MWh	2 MWe
Water (L)	644,000	
Concrete (m^3)	356	
Steel (t)	6	
Liquid fuel (L)	12,200	
Industrial gases[b] (m^3)	258	

[a] Peak demand for electricity is the maximum rate. Peak demand for water is the average daily consumption during a 1-year period with peak construction activity.

[b] Cubic meters measured at standard temperature and pressure.

Source: PX 1995a:6; PX DOE 1995e.

Employment During Modification. The number of workers required during each year of construction at Pantex for the HE downsizing alternative is presented in table A.3.5.1–6.

TABLE A.3.5.1–5.—*Pantex Plant High Explosives Downsizing Construction Emissions*

Pollutant	Quantity (t)
Carbon monoxide	0.54
Nitrogen oxides	0.19
Particulate matter	0.08
Sulfur dioxide	0.02
Total suspended particles	0.19
Volatile organic oxides	0.09

Source: PX DOE 1995e.

Resource Requirements During Operations—High Explosives Fabrication Mission. No additional land is required to operate the HE downsizing alternative at Pantex.

The utilities consumed during operation include electric power, liquid fuels, natural gas, and water. Annual utility consumption rates and peak electric power rates for surge operation are shown in table

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Main Charge Subassembly (Building 12-121). The explosives hemispheres are assembled in Building 12-121.

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Industrial gases[b] (m^3)	258	

[a] Peak demand for electricity is the maximum rate. Peak demand for water is the average daily consumption during a 1-year period with peak construction activity.

[b] Cubic meters measured at standard temperature and pressure.

Source: PX 1995a:6; PX DOE 1995e.

Employment During Modification. The number of workers required during each year of construction at Pantex for the HE downsizing alternative is presented in table A.3.5.1–6.

TABLE A.3.5.1–5.—*Pantex Plant High Explosives Downsizing Construction Emissions*

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Total suspended particles	0.19
Volatile organic oxides	0.09

Source: PX DOE 1995e.

Resource Requirements During Operations—High Explosives Fabrication Mission. No additional land is required to operate the HE downsizing alternative at Pantex.

The utilities consumed during operation include electric power, liquid fuels, natural gas, and water. Annual utility consumption rates and peak electric power rates for surge operation are shown in table

TABLE A.3.5.1–6.—*Pantex Plant High Explosives Downsizing Construction Workers*

Employees	Year 1	Year 2	Year 3	Total
Craftworkers				
Carpenter	1	3	1	5
Construction management and support staff	0	3	1	4
Concrete mason	1	2	1	4
Electrician	0	3	2	5
Iron worker	1	3	1	5
Laborer	1	3	1	5
Millwright	0	1	1	2
Operator	0	1	0	1
Other craftworkers	0	2	1	3
Pipe fitter	0	2	1	3
Sheet metal worker	0	3	1	4
Sprinkler fitter	0	2	1	3
Teamsters	0	1	1	2
Total Employment	4	29	13	46

Source: PX DOE 1995e.

A.3.5.1–7 and are incremental to the A/D mission at Pantex.

All activities would be accomplished on a single, 40 hours-a-week shift. Any surge production would be achieved by increasing personnel and adding shifts (1-year lead time). The facilities would be operated under existing site labor agreements. Surge operation of the HE Fabrication Facility would require 37 direct workers (PX 1996e:1). Support workers for the A/D mission would provide sufficient support for the HE fabrication mission.

TABLE A.3.5.1–7.—*Pantex Plant High Explosives Downsizing Surge Operation Annual Utility Requirements*

Utility	Consumption	Peak Demand[a]
Electricity	3,250 MWh	1 MWe
Liquid fuel (L)	55,600	
Natural gas[b] (m^3)	500,000	
Water (L)	12,500,000	

[a] Peak demand is the maximum rate expected during any time.
[b] Cubic meters measured at standard temperature and pressure.

Source: PX 1995a:5; PX 1995a:6; PX DOE 1995e.

Chemicals Consumed During Operation. The chemicals and materials consumed during operations primarily include water treating chemicals, reactants and solvents for explosives formulation and synthesis, explosive powders, materials for facility equipment and vehicle maintenance, and bottled gases. No radioactive materials are required for explosives production. Materials with annual consumption in excess of 227 kg (500 lb) during surge operations are listed in table A.3.5.1–8.

TABLE A.3.5.1–8.—*Pantex Plant High Explosives Downsizing Surge Operation Annual Chemical Requirements*

Chemical	Quantity (kg)
Calcium chloride	4,080
Ethyl acetate	1,360
HE powders, insensitive	31,600
HE powders, conventional	15,800
Hydraulic/lubricating oil	4,310
Nitrogen	1,810
Paint	2,380

Source: PX 1995a:6; PX DOE 1995e.

Emissions During Operation. Gaseous environmental releases would result from operation of the thermal treatment units for bulk HE waste and nonradioactive HE-contaminated waste generated by Pantex for the explosives production operations. Emissions would also result from plant boiler operation, cleaning operations using solvents, and formulation and synthesis operations. The thermal treatment units would be designed and operated to attain and maintain temperatures which result in the destruction of hazardous constituents. Hazardous particulates would be trapped in filters. The releases would be limited to what is possible, using the best available control technology. The annual chemical emissions for the explosives production surge operations are shown in table A.3.5.1–9.

Waste Management

Wastes Generated During Construction. The liquid and solid wastes generated during construction would include concrete and steel waste construction materials, hazardous wastes, and sanitary wastewater. The steel construction waste material would be

TABLE A.3.5.1–9.—*Pantex Plant High Explosives Downsizing Surge Operation Annual Emissions*

Pollutant	Quantity (kg) Incremental with Assembly/ Disassembly
Criteria Pollutant	
Carbon monoxide	413
Nitrogen oxides	1,560
Particulate matter	68
Sulfur dioxide	0.01
Volatile organic compounds	122
Hazardous and Other Toxic Compounds	
Acetonitrile	0.45
Aldehydes	2.04
Ammonia	0.02
Benzene	3.00
Cresylic acid	0.0014
Cyclohexane	1.70
1,2-Dichloroethane	0.03
Dimethyl formamide	0.01
Dioxane	0.04
Hexane	0.09
Hydrogen chloride	3.20
Hydrogen fluoride	4.50
Mercury	$2x10^{-8}$
Methanol	2.7
Methyl ethyl ketone	349
Toluene	9.5
1,1,1-Trichloroethane	0.54
Trichloroethylene	0.45
Xylene	8

Source: PX DOE 1995e.

recycled as scrap metal. No radioactive or mixed wastes would be generated during construction.

The liquid and solid wastes generated during HE downsized fabrication functions are discussed in the subsections below. The annual quantity of solid and liquid waste generated by the explosives production operations at Pantex during surge operation is shown in table A.3.5.1–10.

Hazardous toxic wastes would consist of solid residue (ash) from thermal treatment units, solvents from operations, wash water and residual reactants from explosives formulation and synthesis, and residue from painting and bonding operations. This waste would be stabilized and sent to an approved permitted RCRA disposal site.

Solid nonhazardous, nonradioactive wastes generated by the explosives production operations would consist primarily of solid sanitary waste, residue from facility and vehicle maintenance, spent desiccants, and sanitized and demilitarized paper and parts. Nonrecyclable portions of this waste would be sent to an offsite landfill. Liquid sanitary wastewater and process wastewater would be treated and discharged to a permitted drainage channel.

Transportation. The major type of hazardous material that would be transported to Pantex would be HE materials. Bulk explosives powders would be delivered to the site by DOT-approved bulk commercial carriers. The powder would be unloaded at the bulk explosives storage facilities, isolated from other facilities on the site. Subsequent movements of HE and explosives components would be performed by trucks and battery powered vehicles specifically designed for this purpose. The quantity of HE (conventional and insensitive) transported onsite by these trucks would be strictly limited.

Explosives main charges and components would be transferred to staging areas for transfer to the A/D plant. In a similar manner, explosives components from the A/D plant would be transferred to the explosives production plant for demilitarization, sanitization, and disposition. Small quantities of hazardous waste generated during operations would be collected, packaged, and transported by electric car to local accumulation sites and then by truck to a staging area. The waste would be transferred by truck for offsite disposal.

A.3.5.2 *Relocate to Los Alamos National Laboratory*

The HE processing facilities at LANL (figures A.3.5.2–1 and A.3.5.2–2) were designed and built for production scale operations and were operated as production facilities supplying nuclear weapons HE components for many years. LANL has continued to upgrade and modernize processing equipment in these existing facilities to provide prototype HE components to meet hydrodynamic and NTS program

TABLE A.3.5.1–10.—*Pantex Plant High Explosives Fabrication Facility Waste Volumes*

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations (m^3)	Annual Volume Effluent from Surge Operations (m^3)
Low-Level			
Liquid	None	None	None
Solid	None	Minimal	Minimal
Mixed Low-Level			
Liquid	None	None	None
Solid	None	None	None
Hazardous			
Liquid	None	0.23	0.23
Solid	0.06	30	30
Nonhazardous (Sanitary)			
Liquid	146	7,120	7,120
Solid	None	17	8[a]
Nonhazardous (Other)			
Liquid	Included in sanitary	None	None
Solid	2[b]	Included in sanitary	Included in sanitary

[a] Assumes 2/3 of solid sanitary waste is compactible by a factor of 4:1.

[b] Includes 2 m^3 of concrete and 0.25 t (0.28 tons) of recycled steel. Density of steel was assumed to be 0.127 m^3/t for volume conversion.

Source: PX 1995a:5; PX 1995a:6; PX DOE 1995e.

requirements. Using the existing HE manufacturing infrastructure along with state-of-the-art processing equipment, LANL produces high-quality complex HE components to meet one-of-a-kind prototype requirements or limited production runs of HE components used in test programs. Typically, LANL fabricates an average of 1,200 to 1,500 HE parts per year. Surveillance (returned stockpile) HE components are also processed for weapon aging studies.

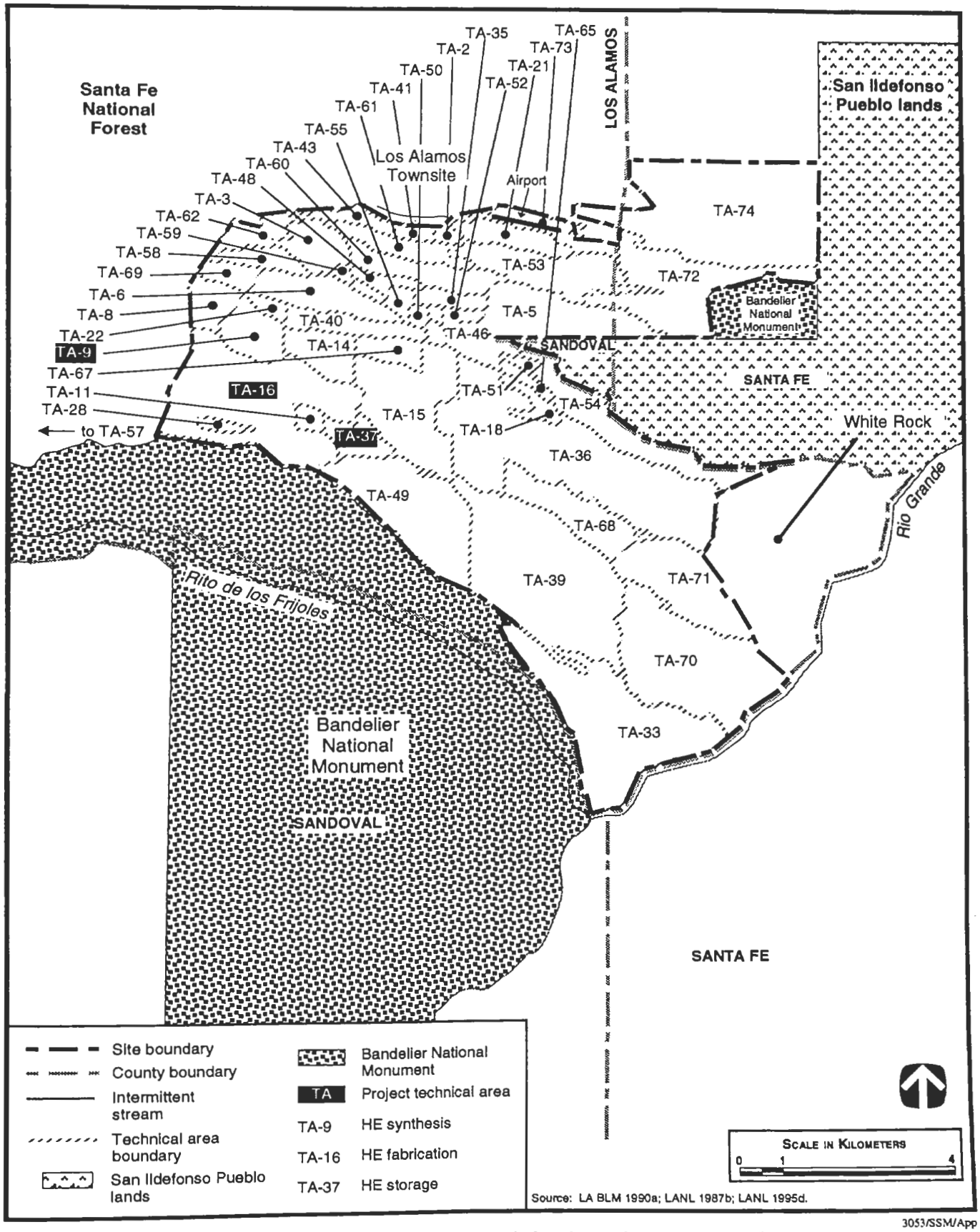
LANL's full range of HE-processing capabilities includes HE storage magazines, HE synthesis, HE formulation, pressing, machining, assembly, and subassembly of HE devices, proven quality assurance processes, and stringent disposal requirements. In addition, LANL has facilities for environmental, safety, and performance testing of HE and HE assemblies. In all, the inherent capacity of the LANL HE plant exceeds weapons R&D testing program requirements. Furthermore, expanding workloads at LANL to support the projected production would not tax or require full capacity of LANL's existing infrastructure.

LANL would assume the responsibility for providing all HE feedstock, main charge, and component procurement, and fabrication as required by the HE fabrication mission. The products and capabilities for which LANL would be responsible are shown in table A.3.5.2–1.

Assumptions. The general and facility assumptions on which the data in this section are based follow.

General Assumptions

- LANL currently has adequate infrastructure in place to meet all ES&H safeguards and security and waste management requirements for the HE fabrication mission.
- Additional staff would be required to support new HE production.
- Transition from Pantex and qualification and process prove-in will take approxi-



3053/SSM/App

FIGURE A.3.5.2–1.—***High Explosives Fabrication Alternative Technical Areas at Los Alamos National Laboratory.***

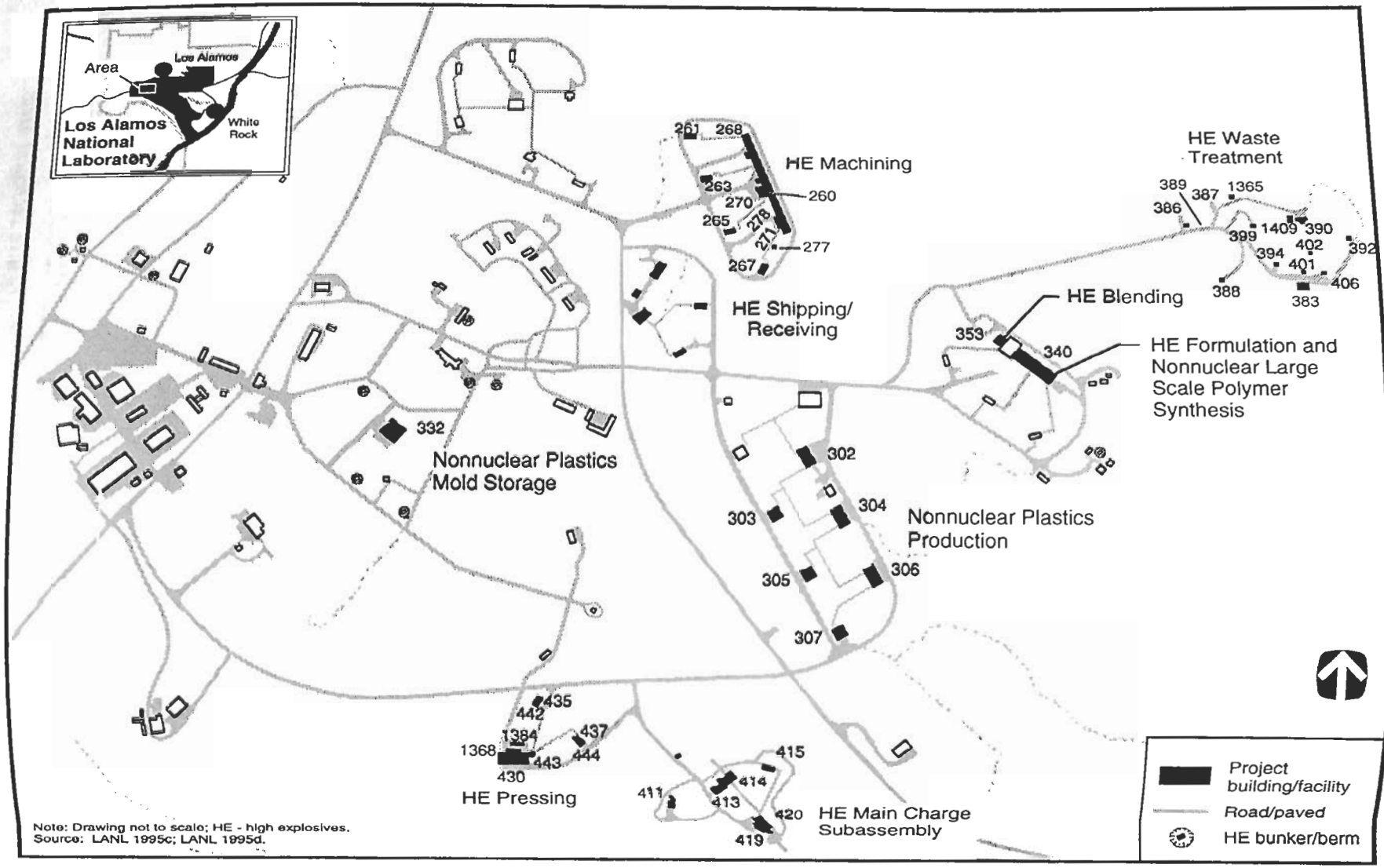


FIGURE A.3.5.2–2—*Technical Area 16 Site Plan at Los Alamos National Laboratory.*

mately 2 years, beginning in fiscal year 1997 after the ROD.

- Steady state operations begin at LANL in fiscal year 1999.
- Steady state operations include manufacturing, testing, and quality assurance evaluation of parts and returned stockpile surveillance components (approximately 10 percent of the production rate).

Facility Capacity/Capabilities Assumptions

- The capacity is defined as 150 sets of explosives components for new builds and 110 sets of explosives components for rebuilds.
- All products and capabilities defined by the HE manufacturing block flow diagrams will be supported.
- Some existing programs in the enduring stockpile use main charges made from conventional HE. All new weapon programs will use main charges made from insensitive HE. Insensitive HE machining and storage continue to be explosive hazard Class IV operations.
- Appropriate portions of the existing storage facilities will be upgraded and reserved to provide adequate storage for the HE fabrication mission, estimated as 182,000 kg (400,000 lb) of insensitive HE and 31,750 kg (70,000 lb) of conventional HE.
- Existing S-Site facilities will be operated according to the current shift system (four 10-hour days per week) to meet normal production requirements. The facilities will be operated under existing labor agreements.

TABLE A.3.5.2–1.—*Los Alamos National Laboratory High Explosives Fabrication Products and Capabilities*

Products	Capabilities
High Explosives	**Manufacturing Process Development**
	Stockpile stewardship support
	Formulation
	Surveillance
	Synthesis
Binders	**Main Charge Manufacturing**
	Pressing
	Machining
	Subassembly
	Receiving/storage
	Quality assurance-mechanical/chemical/test fire
	Disposition
Main Charge Formulations	**Energetic Component Manufacturing**
	Pressing
	Machining
	Subassembly
	Receiving/storage
	Quality assurance-mechanical/chemical/test fire
	Disposition
Initiation High Explosives	**Detonators**
Mock High Explosives Formulations	**Testing**

Source: LANL 1995d.

- No new facility construction will be needed.

Facility Description. LANL has all the facilities and equipment needed to carry out the HE fabrication mission. These HE processing facilities are located primarily in TAs -9 and -16. The synthesis, analytical laboratory, and pilot scale formulation activities are located at TA-9. These facilities, including administrative support and HE storage, comprise 39 buildings with over 3,700 m^2 (40,000 ft^2) of floor space. Formulation, pressing, machining, receiving, storage, subassembly, radiography, and disposal processes are carried out at TA-16, which houses 65 buildings covering over 8,900 m^2 (96,000 ft^2). Testing and nondestructive evaluation would be carried out in a variety of other TAs. TA-37 would provide storage of HE parts and components. All LANL facilities are designed to meet the requirements of the *DOD Ammunition and Explosive Safety Standards* (DOD 6055.9) and the *DOE Explosives Safety Manual* (DOE/EV/06194) for quantity-distance and operational criteria. The HE safety requirements applicable to operations involving the development, testing, handling, and processing of explosives or assemblies containing explosives are identified in DOE/EV/06194. This manual reflects the state of the art in HE safety. Again, no new construction or major equipment transfers from Pantex are required to support the HE fabrication mission at LANL.

State- and Federal-permitted waste disposal facilities are located at TA-54 for hazardous materials (non-HE contaminated) and at TA-16 for HE and HE-contaminated waste. LANL operates in compliance with all state and Federal requirements and regulations, applying a process of continuous process improvements to drive an effective "best practices" program in waste minimization.

Currently, processing routing flow sheets accompany HE components as they are moved through each processing step. Operators sign off as each process is completed. When the processing is completed, the flow sheets are sent to production control where the processing and inspection data are entered into databases and then filed in production control files. Database inventories and task order files are kept on all components, assemblies, and raw materials used in the HE Fabrication Facility.

Although the facilities are in remote locations, th are well integrated into the infrastructure of LAN They all have intrasite transportation connections that transportation of explosives and components public roads is not of concern for operation Because of their location, HE facilities are w buffered and are not subject to population pressur

The HE facilities are primarily centralized in t Dynamic Experimentation and Engineering Scienc and Application Divisions and are used in support DOE and DOD programs. These facilities will b used for the HE fabrication processes includin synthesis and formulation, main-charge manufactu ing, testing and characterization, small componer manufacturing, HE storage, and disposition. Th TAs used to support the production include TAs -8 -9, -11, -14, -15, -16, -21, -22, -28, -36, -37, -39, an -40. The majority of the HE processing operation are located at TAs -9, -16, -28, and -37.

HE performance testing and characterization can be conducted at any of several firing sites operated by DX Division. TAs include TAs -14, -15, -16, -21, -22, -36, -39, and -40. Hazardous waste treatment and disposal facilities are located at TA-54, while HE disposal facilities are located at TA-16.

Design Safety. Important safety considerations are incorporated into the design of DOE facilities. Performance goals commensurate with the associated hazard are selected for all structures, systems, and components. The term "hazard" is defined as a source of danger, whether external or internal. Natural phenomena such as earthquakes, extreme winds, tornadoes, and floods are external hazards to structures, systems, and components; whereas, toxic, reactive, explosive, or radioactive materials contained within the facilities are internal hazards. Usage category is as established by DOE management. Guidelines for usage category (performance category) and the corresponding performance goals are given in UCRL-15910.

Earthquake. All existing HE fabrication structures located in Dynamic Experimentation and Engineering Sciences and Application Divisions meet all current applicable standards. An engineering study showed that the reinforced concrete structures used for HE processing buildings used for blast loading requirements exceed the seismic loading for struc-

tural capacity. New structures, systems, and components, when required, shall be designed for earthquake-generated ground accelerations in accordance with UCRL-15910, with applicable seismic hazard exceedance probability of $2x10^{-3}$ for general use (performance category 1), $1x10^{-3}$ for low and moderate hazard (performance category 2 and 3), and $2x10^{-4}$ for high hazard (performance category 4) structures, systems, and components.

Wind. All existing HE fabrication structures at TA-9 and TA-16 meet the wind criteria as discussed below. All new structures, systems, and components would be designed for wind or tornado load criteria when required in accordance with UCRL-15910 and the corresponding facility usage and performance goals. Wind loads shall be based on the annual probability of exceedance of $2x10^{-2}$ for the general and low hazard (performance categories 1 and 2), $1x10^{-3}$ for the moderate hazard (performance category 3), and $1x10^{-4}$ for the high hazard (performance category 4) structures, systems, and components. Wind design criteria is based on annual probability of exceedance, importance factor, missile criteria, and atmospheric pressure change, as applicable, to each performance (usage) category as specified in UCRL-15910.

Floods. All HE facilities and buildings at the LANL HE Fabrication Facility are located above the critical flood elevation from the potential flood source (river, dam, levee, precipitation, etc.). The extent of the flood hazard is determined using the appropriate usage (performance) category for determining the annual hazard probability of exceedance: $2x10^{-3}$ for general use (performance category 1), $5x10^{-4}$ for important or low hazard (performance category 2), $1x10^{-4}$ for moderate hazard (performance category 3), and $1x10^{-5}$ for high hazard (performance category 4) facilities as defined in UCRL-15910.

The critical flood elevation is determined by obtaining the design basis flood level. The design basis flood level is the peak hazard level (flow rate, depth of water, etc.) corresponding to the mean annual hazard probability of exceedance or combinations of flood hazards (river flooding, wind-wave action, etc.) and corresponding loads associated with the peak hazard level and applicable load combination (hydrostatic and/or hydrodynamic forces, debris loads, etc.). LANL run-off site drainage conforms to the State of New Mexico and NPDES requirements. The minimum design level for the stormwater management system is the 25-year, 6-hour storm, but potential effects of larger storms up to the 100-year 6 hour storm are also considered.

Fire Protection. The fire protection features for the existing HE Fabrication Facility and its associated support buildings are in accordance with DOE orders and the National Fire Prevention Association Fire Codes and Standards.

Redundant firewater supplies and pumping capabilities (electric motor drivers with diesel generator backup) would be installed to supply the automatic and manual fire protections systems located throughout the site. One tank and one set of pumps would be designed to meet design basis event requirements. Appropriate types of fire protections systems would be installed to provide life safety, to prevent large-loss fires, to prevent production delay, to ensure that fire does not cause an unacceptable onsite or offsite release of hazardous material that would threaten the public health and safety or the environment, and minimize the potential for the occurrence of a fire and related perils. Specific production areas and/or equipment would be provided with the appropriate fire detection and suppression features, as required, with respect to the unique hazard characteristics of the product or process.

A fire hazards analysis would be performed to assess the risk from fire within the individual fire areas of the facility. All fire sprinkler water that has been discharged during and after a fire would be collected in building sump systems, monitored, sampled, and, if required, retained until it could be disposed of.

Safeguards and Security Systems Description. The HE fabrication facilities located at TA-9 and TA-16 are located within a security parameter with multiple fences surrounding the areas. The main large scale HE processing buildings, assembly area, and magazine storage areas at TA-16 and TA-37 are located within a separate fenced HE exclusion area.

Safety Class Instrumentation and Control. The safety classification of instrumentation and controls is derived from the safety function each performs. This safety classification is based on appropriate DOE orders. HE facilities at LANL that

utilize instrumentation for explosives operations currently meet all the safety class requirements.

Ventilation. The heating, ventilation, and air conditioning system provides environmental conditions for the health and comfort of personnel and for equipment protection.

Internal Explosion. New and existing buildings are designed for the effects of accidental explosion within a bay or cell. The design is in accordance with the *DOE Explosives Safety Manual* (DOE/EV/06194), including the quantity-distance and the level of protection criteria for each class of explosives activities.

Overall Facility Layouts and Design Descriptions. The existing HE fabrication facilities at LANL would be used to support the production mission for HE fabrication. These facilities were designed to meet the *DOD Ammunition and Explosives Safety Standards* (DOD 6055.9) and DOE/EV/06194. Operations are segregated by hazard class: Class I processes, the most hazardous processes, were designed for remote operations with an accidental detonation venting the process bay via a frangible (blow-out) wall away from inhabited areas. Fragment distances and blast overpressure (interline distance) set the criteria for locating operating buildings.

All LANL HE processing facilities are designed for Class I (remote) and Class II (operated attended) operations as defined by DOD 6055.9. While some processing operations require some minimal changes for processing conventional HE, there are no major differences in equipment or facilities. The just-in-time flexible manufacturing approach allows the facilities to alternately process both insensitive HE and conventional HE in the same equipment and facilities. This operational philosophy allows optimized fabrication of all HE and gives the flexibility to make production lots of materials, as required (i.e., plane wave lenses), as well as to manufacture a single quantity of weapon HE components for local hydrodynamic tests and custom HE part requirements.

Structures containing HE and those in which HE operations are conducted are constructed with thick (0.6-m [2-ft]) thick, steel-reinforced, concrete walls designed to mitigate the effects of an accidental explosion. These facilities contain protective ber and are located to meet quantity-distance criter Most facilities include support areas for offic break rooms; restrooms; electrical equipme heating, ventilation, and air conditioning equipme maintenance; and in-process staging of materia components, tooling, and supplies. Table A.3.5.2- lists functional HE processing technology, buildi numbers, and working floor space. No new facilitie or structures are required to support the HE manufa turing production mission.

High Explosive Main-Charge Manufacturing. Th HE processing facility is used to manufacture mai charge subassemblies, mock main charge hemi spheres, and explosive test specimens. An area i also provided for conducting physical property testing on explosives components and materials. Each functional area is described below:

Isostatic Pressing. Rough pressings for HE main charge subassemblies, material test billets, and pellets for small components and boosters are fabricated in TA-16-430.

Explosives Machining. Rough pressings are radiographed, inspected, and machined into hemispherical shapes or test charges in TA-16-260.

Inspection. HE components are inspected in TA-16-260.

Main Charge Subassembly. The explosives hemispheres are assembled in TA-16-410.

Small High Explosives Component Manufacturing. This facility manufactures small HE weapon components and test assemblies and conducts qualification and development testing for explosives components and materials. Various small components are manufactured in TAs-16-340, -430, -260, and -410 from HE powders and binders, metal or plastic components, electrical components, hardware, and assembly materials. The manufacturing process requires equipment for explosives powder heating, pellet pressing, laser welding, ultrasonic cleaning, extrusion loading, density testing, and mechanical assembly.

Inert Machining. Small components are manufactured in TA-16-370 and TA-3-39. Additional facili-

TABLE A.3.5.2–2.—*Los Alamos National Laboratory High Explosives Fabrication Facility Data*

Functional Area	Existing Facilities	
High Explosives Technology	Gross Area (m^2)	Building Number
Main Charge Fabrication		
HE pressing	740	TA-16-430
HE machining, inspection	930	TA-16-260
HE subassembly	370	TA-16-410
Physical property testing	185	TA-11, All
High Explosives Staging, Insensitive High Explosives, and Conventional High Explosives	280	TA-16-261 TYPICAL
Main Charge Test Fire	93	TA-15, TA-40
Energetic Components		
Small component fabrication	700	TA-16-340
Test fire	93	TA-15, TA-40
Component nondestructive evaluation	560	TA-8-22, -23
Formulation and Synthesis		
HE synthesis	460	TA-9-45, -46
HE formulation	700	TA-16-340
Chemical storage	47	TA-16-344
HE staging	47	TA-16-341, -343, -345
Production Support		
Analytic/environmental lab	460	TA-9-21 and -32
Metrology	185	TA-16-260, -410
Materials compatibility testing	280	TA-9-21, -40, -42
Machine shop	185	TA-16-370
High Explosives Shipping/Receiving	230	TA-16-280
Outdoor Test Fire	93	TA-15, TA-11
High Speed Test Machining	18	TA-16-340, -476
High Explosives Storage, Insensitive High Explosives, and Conventional High Explosives	930	TA-37-1 through -37
High Explosives Tech Ramps	2,790	TA-16-413, -332
Component Warehouse	280	
Total	10,655	

Source: LANL 1995d.

ties at the central shop (TA-13-39) include full service, high precision metal manufacturing capability.

Synthesis (Technical Areas 9-45, -46) and Formulation (Technical Area 16-340). These facilities have the capability to produce a variety of explosives materials from chemical reactants or to formulate HE composites from commercially produced explosives. Material lots up to about 91 kg (200 lb) are produced through a series of batch operations. Some products are used to make small HE weapons components, while other products support the development of new explosives or explosives manufacturing processes. Blending capabilities for producing uniform blends up to 454 kg (1,000 lb) to minimize batch-to-batch variations are available at the TA-16-340 complex. The HE formulation and synthesis facility includes several flexible processing bays that contain a variety of vessels, filters, and transfer pumps which are used to synthesize, recrystallize, blend, and wash explosive powders. The facility also includes six bays for mixing/milling, particle size reduction (micronization), drying/weighing/packaging, solvent storage, and refrigerated storage for explosives and chemicals.

High Explosives Shipping and Storage. The HE shipping/receiving facility in TA-16-280 and TA-37-1 through TA-37-26 is designed to ship and receive bulk HE materials to and from the HE Fabrication Facility. These materials are typically received in 4,500 to 9,000 kg (10,000 to 20,000 lb) lots. Parts would be shipped out as needed in small lots to the A/D Facility.

High Explosives Disposal (Technical Area 16-389). LANL disposal facilities is in place and permitted by the State of New Mexico for disposal of HE waste and HE-contaminated materials. There is a large flash pad that thermally decontaminates items subject to trace HE contamination prior to burial. Two aboveground burning trays are used to destroy HE scrap and residue, and two sand filters are used to remove HE-contaminated water from sump sludge for drying and burning. One aboveground tray burns contaminated oil. An incinerator burns room trash from the HE area (potential contamination due to association only). All water is filtered to remove HE; treated with activated carbon for solvent removal; and measured for chemical oxygen demand, suspended solids, and acidity prior to release to the environment.

Explosives Testing and Characterization. HE testing and characterization cover a wide range of activities and processes and provide quality assurance data that can be used to certify a HE lot for production use or to provide test firing information to qualify small HE component lots for use in production assemblies. LANL has facilities, instrumentation, and test equipment to support the certification of HEs and HE components that would be used for production. These facilities can be used for analytical chemistry evaluation, physical testing, nondestructive evaluation, materials compatibility testing, and firing sites for performance and safety evaluations of HEs and HE assemblies. The full complement of testing and characterization activities is used for surveillance evaluation of returned stockpile HEs.

Analytical Laboratory. Chemical analyses are performed in TA-9-21 on explosives and on explosives materials to determine or verify their characteristics. Analysis methods include gas chromatography, liquid chromatography, ion chromatography, size exclusion chromatography, infrared spectroscopy, thermal analysis, particle characterization, mass spectroscopy, atomic spectroscopy, a emission spectroscopy. Small-scale safety te required for evaluation of HEs are conducted in t facility. Tests include drop weight impact, fricti electrostatic discharge, and thermal tests.

Material Compatibility Testing. Test coupons a assembled in TA-9-40, TA-9-21, and TA-9-42 so th the subject materials are in direct contact with ea other. These coupons are then placed in environme tal chambers to accelerate the aging process. Ter peratures can be cycled between -55 °C (-67 °F) a +75 °C (+167 °F) in the chambers. Gas samples a periodically taken from the coupon containers an analyzed. Compatibility testing is required to certif new materials for weapon use and HE compatibility Two large environmental chambers that can be use for cycling full scale weapons systems are located i TA-9-42.

Physical Properties Testing. The physical properties of explosives components and materials are tested in TA-16-340 and TA-9-37 to support lot certification for materials and components and to support production development. The test configurations are assembled, and tensile, torsion, and compression tests are conducted.

Nondestructive Evaluation. Explosives and nonexplosives components are inspected in TAs-8-22, -23, -70 and TA-16-260 with neutron, x-ray, magnetic particle, and eddy current equipment to detect flaws, cracks, voids, and foreign materials.

Test Firing. LANL assembles and detonates explosive test configurations in TA-15, TA-40, and TA-11-25. Tests require explosive containment chambers and an array of special instrumentation including streak cameras, rotating mirror framing cameras, an air image converter system, digital oscilloscopes, flash x-ray systems, and velocity interferometers. LANL conducts large-scale safety tests such as skid tests and spigots at the TA-11 drop tower facility. Vibration test capabilities are also located in this area and can be used for full scale weapons tests as well as components tests.

High Explosives Staging Areas and Corridors. In-process storage in TA-16 is required for a variety of HE powders, components, and assemblies for supporting the HE fabrication operations. These explo-

sives materials include PBXs for main charge manufacturing, completed main charges, small HE components, energetic feed materials and products for HE formulation and synthesis, and explosives residues for disposal or recycle. Staging magazines exist in conjunction with each operational building. The staging magazines are connected with the operational buildings with enclosed corridors. These corridors are used for equipment and material transfers only. Major process buildings are not interconnected.

Resource Requirements During Construction/Modification/Transition. Since only minimal new equipment is needed at LANL, there are no facility construction or modification requirements to conduct the HE fabrication mission at LANL. LANL already has all the technologies needed to provide HE materials, component fabrication, characterization, surveillance, and quality assurance for the future nuclear weapons requirement. The capacity of LANL HE fabrication facilities exceeds R&D mission requirements and can easily accommodate the required production load.

LANL has a full spectrum of HE research, development, fabrication, and test capabilities managed by the Dynamic Experimentation and Engineering Sciences and Applications Divisions. The existing facilities, equipment, and infrastructure would be used to satisfy future production requirements for the HE fabrication mission. The existing capabilities are used to manufacture prototype weapon components for full scale testing that provide the basis for production specifications. Additionally, LANL has demonstrated the capability to manufacture limited production quantities of HE components. Typically, LANL produces 1,200 to 1,500 HE parts per year for use in the weapons research development and testing programs, which include requirements for small production lots (~500) of HE components. These components are manufactured to strict quality assurance requirements and are used in complex hydrodynamic and NTS program requirements.

The equipment and processes used in the HE fabrication processes are very similar and in some cases identical to those used at Pantex for production. By using the same equipment and processing technologies, both LANL and Pantex manufacture parts by the same methods. The processes used by Pantex for HE component production would be used by LANL, except in rare cases where process and/or product improvements can be demonstrated to be cost effective and still meet production requirements. Transition of the HE fabrication processes from Pantex to LANL would require very little press development since equipment and processes are almost identical.

The transition period for transferring the HE fabrication mission to LANL is estimated to take 2 years after the ROD of this PEIS. HE main-charge components may exhibit dimensional instabilities (material creep) when stored for periods of time in excess of 6 to 8 months. Production scheduling plans for "just-in-time" manufacturing of HE components to be used in weapon assemblies. Additionally, extrudable HE used in weapons application, must be stored at -30 °C (-22 °F), and have a 24-hour room temperature working life before the materials cure and setup. The shelf life of the extrudables, when stored at -30 °C (-22 °F), is typically on the order of 6 to 8 months. Because of these concerns, it is not feasible to prebuild HE components during the transition period. It will be necessary for Pantex to remain operational for producing HE components until the receiver site becomes operational. For LANL, this transition period would require 2 years, with steady state operations beginning in fiscal year 1999.

Resource Requirements During Operations–High Explosives Fabrication Mission. HE operations are conducted within the existing LANL boundaries and occupy approximately 5,180 ha (12,800 acres). Table A.3.5.2–2 lists all the required facilities for HE fabrication operations at LANL and the footprint or area on the ground required for each facility.

General utilities and resource requirements including electric power, steam, natural gas, liquid fuels, and water would be supplied by existing LANL infrastructure. Capacity of the general utilities support is sufficient to meet the current requirements of the HE Fabrication Facility for R&D operations and an increase in capacity to meet production requirements is not needed. The utilities and resources consumed during operations include electric power, liquid fuels, natural gas, and water. Annual utility resource consumption rates and peak electric power rates for surge operation are estimated in table A.3.5.2–3.

TABLE A.3.5.2–3.—*Los Alamos National Laboratory High Explosives Fabrication Surge Operation Annual Utility Requirements*

Utility	Consumption	Peak Demand[a]
Electricity	5,600 MWh	1.0 MWe
Liquid fuel (L)	94,600	
Natural gas[b] (m^3)	3,650,000	
Coal (t)	0	
Water (L)	13,000,000	

[a] Peak demand is the maximum rate expected during any time.
[b] Standard cubic meters standard temperature and pressure.
Source: LANL 1995b:4; LANL 1995d.

LANL's HE fabrication processing facilities currently operate on a 4-day week, 10 hours per day, for 50 weeks per year. Maintenance personnel that support the HE processing equipment work a 5-day week, 8 hours per day. Routine and preventive maintenance is conducted on Fridays, as scheduling permits. Actual operational schedules will be dependent on workload and scheduling requirements.

Table A.3.5.2–4 provides the estimated number of additional direct operating and direct support personnel required at LANL to meet the HE fabrication requirements under base case surge (three shifts per day) operation. The DOE production control documents for the enduring stockpile systems would be used for planning and scheduling of the HE components needed to meet the production requirements. In addition, manpower estimates for manufacturing quality assurance parts and preparing surveillance samples for testing and evaluation have been included.

TABLE A.3.5.2–4.—*Los Alamos National Laboratory High Explosives Fabrication Surge Operation Workers*

Labor Category	Number of Workers
Direct workers	35
Direct support workers	30
Operations support workers	40
Indirect support workers	95
Total	200[a]

[a] Total surge employment. Increase to current employment would be 67.
Source: LANL 1995b:4; LANL 1995d.

Chemicals Consumed During Operation. Th chemicals consumed during all HE fabrication op ations are shown in table A.3.5.2–5.

Emissions During Operations. The HE fabricati operations at LANL do not require radiological mat rials. Under normal operations, no workers could b exposed to radiation. Emissions during operation a listed in table A.3.5.2–6. Gaseous environmenta releases would result from operation of the therm treatment units (incinerator baseline) for bulk HE waste and nonradioactive HE-contaminated waste Emissions would also result from plant boiler opera tion, cleaning operations using solvents, and smal scale synthesis operations, although the incremental amount of emissions over current operations would be very small. The thermal treatment units would be designed and operated to attain and maintain temperatures which would result in the destruction of hazardous constituents. Hazardous particulates would be trapped in filters. The releases would be limited to as low as achievable using the best available control technology.

Waste Management. Liquid and solid waste streams generated by the HE fabrication operations are processed to meet state, Federal, and DOE requirements for the various types of nonhazardous, hazardous, radioactive, and mixed wastes. LANL waste management facilities would be used to receive, track, characterize, treat, package, store, and ship wastes generated by HE plant operations. These facilities include a waste management operation, waste storage facility, sanitary wastewater treatment unit, and a sanitary and industrial landfill.

Nonhazardous wastes generated at the HE Fabrication Facility would primarily consist of solid sanitary waste, sludge from sanitary wastewater treatment, maintenance residues, and scrap parts. Materials unsuitable for recycle would be appropriately disposed of in an approved landfill. Liquid sanitary wastewater will be discharged to the environment after treatment, subject to the NPDES requirements.

Hazardous wastes generated by the HE Fabrication Facility would consist of solid residue from thermal treatment of scrap explosives and explosive-contaminated combustible materials, spent carbon from HE- and solvent-contaminated water treatment, and waste oils and paint residues from routine maintenance

TABLE A.3.5.2–5.—*Los Alamos National Laboratory High Explosives Fabrication Surge Operation Annual Chemical Requirements*

Chemical	Quantity (kg)	Chemical	Quantity (kg)
Acetone	2,722	Ethylene glycol	227
Acetonitrile	1,814	X-Ray film developer, fixer, and toners	227
Acid neutralizers/spill kits	272	HE powders	45,360
Adiprene polyurethane composition	45	Hydrochloric acid	45
Activated carbon	454	Hydraulic lube oils	2,268
Aluminum metal	454	Mild steel	454
Argon	907	Nitrogen	227
Carbon dioxide	227	Silicone elastomer	91
Cyanuric acid	454	Sodium hydroxide	227
Degreaser	45	Stainless steel	454
Desiccants/molecular sieves	136	Talc	454
Elastomer binders	227	Tetrahydrofuran	113
Ethanol	272	Toluene	680
Ethyl acetate	454	Water chemicals	91

Source: LANL 1995b:4; LANL 1995d.

TABLE A.3.5.2–6.—*Los Alamos National Laboratory High Explosives Fabrication Surge Operation Annual Emissions*

Pollutant	Quantity (kg)
Criteria Pollutants	
Carbon monoxide	4,540
Nitrogen oxides	22,700
Particulate matter	227
Volatile organics	4,540
Hazardous and Other Toxic Compounds	
Ammonia	454
Acetonitrile	4.5
Cyclohexane	2.3
Dioxane	2.3
Hydrogen chloride	113
Hydrogen fluoride	45.4
Methyl ethyl ketone	22.7
Toluene	22.7

Source: LANL 1995d.

operations. LANL would stabilize all hazardous materials for disposal/treatment at an approved RCRA disposal site.

Low-level radioactive waste would only be generated from A/D operations involving depleted uranium parts, or from processing of surveillance materials or other HE charges returned from stockpile with slight contamination. There would be no radioactive wastes associated with HE fabrication. In all cases, compliance with all appropriate regulations and standards concerning all wastes, including mixed waste, would be met.

HE residual materials, such as bulk HE machining scrap, off-specification HE components, HE-contaminated materials (including gloves, wipes, and rags) and process water generated during HE fabrication operations are the source of most of the waste material that must be processed. LANL uses waste minimization and recycle processes to reduce the amounts of material that ultimately must be subjected to waste treatment processes. Recycled scrap HE and HE-contaminated process water are not considered waste and are handled as in-plant operations.

Currently, thermal treatment of HE and HE-contaminated materials (open air burning and incinerators) are the preferred permitted techniques used to dispose of and decontaminate solid materials. LANL is looking at several alternative processes in the event state and Federal agencies do not approve permit applications. Some of these processes include base-hydrolysis decomposition of HE, followed by supercritical water oxidation, molten salt destruction, and bioremediation techniques. The open burning and incineration techniques at LANL are subject to environmental monitoring, and emissions must meet permit requirements.

HE-contaminated process water generated by synthesis and formulation processes, vacuum pump seal water, and HE machining processes, would be collected in tanks and then treated with activated carbon filters to remove residual HEs and solvents. The water would then be recycled or discharged to the environment subject to NPDES permit requirements. LANL collects sanitary wastewater in a separate system and routes it to septic tanks or sanitary waste water treatment facilities. Stormwater is collected separately, and a stormwater pollution prevention plan is in place.

The thermal treatment of HE scrap and HE-contaminated materials would result in emission of decomposition gases. Typical decomposition gases include carbon monoxide, oxide of nitrogen, volatile organics, hydrogen chloride, hydrogen fluoride, and ammonia. Small amounts of organic solvent vapors from materials such as toluene, acetone, methyl ethyl ketone, and ethyl acetate can also be generated during treatment processes as well as normal plant operations.

All LANL operations involving HE, including waste disposal, must comply with DOE/EV/106194 and meet explosives safety requirements. Buildings meet blast-resistant building construction standards and quantity distance criteria. Remote operations capabilities exist for disposal processes.

The HE fabrication process would generate the following waste and residual materials:

- Bulk HE machining scrap
- Off-specification HE components
- HE-contaminated materials, such as gloves and wipes, from manual cleaning operations
- Glycerin pressing fluid
- Developing materials from x-ray and n-ray film processing
- Hazardous contaminated materials from chemical bonding operations, packaging/repackaging, storing/staging, and shipping for ultimate disposal.

Several facilities exist within LANL's waste manag ment infrastructure that process the plant non-h wastes. These facilities are used to receive, tra characterize, treat, package, store, and ship was generated by HE fabrication operations. Included a a waste storage facility, a sanitary wastewat treatment unit, a sanitary and industrial landfill, a stormwater ponds. Hazardous waste that has be HE decontaminated would be handled through t LANL waste management operations at TA-54. Th increased loading on the LANL infrastructure whi handles these types of wastes would be minim requiring no additional capacity or facilities. Th radioactive wastes, mixed wastes, hazardous waste and nonhazardous wastes generated during the sur operations are quantified in table A.3.5.2–7.

Transportation. All intrasite transportation requir for manufacturing is done within existing site boun aries and does not require use of public road Appropriate HE shipping regulations as defined b DOE and DOT are followed.

The HE shipping and receiving facility is designed t ship and receive bulk HE materials to and from th HE Fabrication Facility. These materials ar typically received in 4,500 to 9,000 kg (10,000 t 20,000 lb) lots. All completed charges are shippe following appropriate HE shipping regulations. Al hazardous chemicals are shipped using appropria DOT requirements.

A.3.5.3 *Relocate to Lawrence Livermore National Laboratory*

LLNL maintains self-contained HE RD&T, and fabri cation capabilities at the remote explosives testing

TABLE A.3.5.2–7.—*Los Alamos National Laboratory High Explosives Fabrication Waste Volumes*

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations (m^3)	Annual Volume Effluent from Surge Operations (m^3)
Low-Level			
Liquid	None	None	None
Solid	None	Minimal	Minimal
Mixed Low-Level			
Liquid	None	None	None
Solid	None	None	None
Hazardous			
Liquid	None	4[a]	4
Solid	None	13	13
Nonhazardous (Sanitary)			
Liquid	None	5,900	5,880[b]
Solid	None	Included in liquid	17
Nonhazardous (Other)			
Liquid	None	6,930[c]	6,930
Solid	None	28	28

[a] Includes HE process solvents and contaminated oils.

[b] Assumes 350:1 wastewater to sludge ratio in treatment of liquid sanitary waste.

[c] Treated process water to NPDES permitted outfalls.

Source: LANL 1995b:3; LANL 1995b:4; LANL 1995d.

area, Site 300, and at the HE Applications Facility at the Livermore Site. LLNL has the facilities, equipment, and infrastructure to satisfy the current production requirements for the HE fabrication mission for all weapon systems in the enduring stockpile. The health and safety, materials management, and materials characterization (nondestructive examination, test fire, and chemical analysis) infrastructures are already in place and available to support the production function as well as the R&D function. No significant HE Applications Facility or Site 300 upgrades are anticipated to receive the mission for HE fabrication in the Complex. No deviations from the current baseline technologies at Pantex are anticipated.

Site 300 is dedicated to all aspects of HE RD&T and is remotely situated on 2,800 ha (7,000 acres) in California's Central Valley, 24 km (15 mi) east of the Livermore Site (figure A.3.5.3–1). Large-scale synthesis, formulation, and test firing is done at Site 300. The HE Applications Facility staff administers the technical work from the Livermore Site. Small-scale process development/prove-in would be done in the HE Applications Facility. The HE Applications Facility meets or exceeds all the applicable ES&H requirements for explosives R&D and production support. Synthesis and formulation would be performed in this building and would be locally supported by the theory and modeling efforts in the HE Applications Facility. A full spectrum of other HE activities take place at this facility, ranging from detonator development to experiments involving 10-kg (22-lb) detonations.

No significant upgrades to the HE Applications Facility would be required. Larger-scale work at Site 300 is done in parallel with the HE Applications Facility's small-scale process development. Both sites are fully self-contained installations. Site 300's synthesis and formulation complex provides the capability to conduct both remote and contact HE operations in facilities that meet current DOE design levels of environment, safety, and health protection criteria, as well as the current regulatory requirements of applicable Government agencies. LLNL would assume responsibility for providing all HE feedstock,

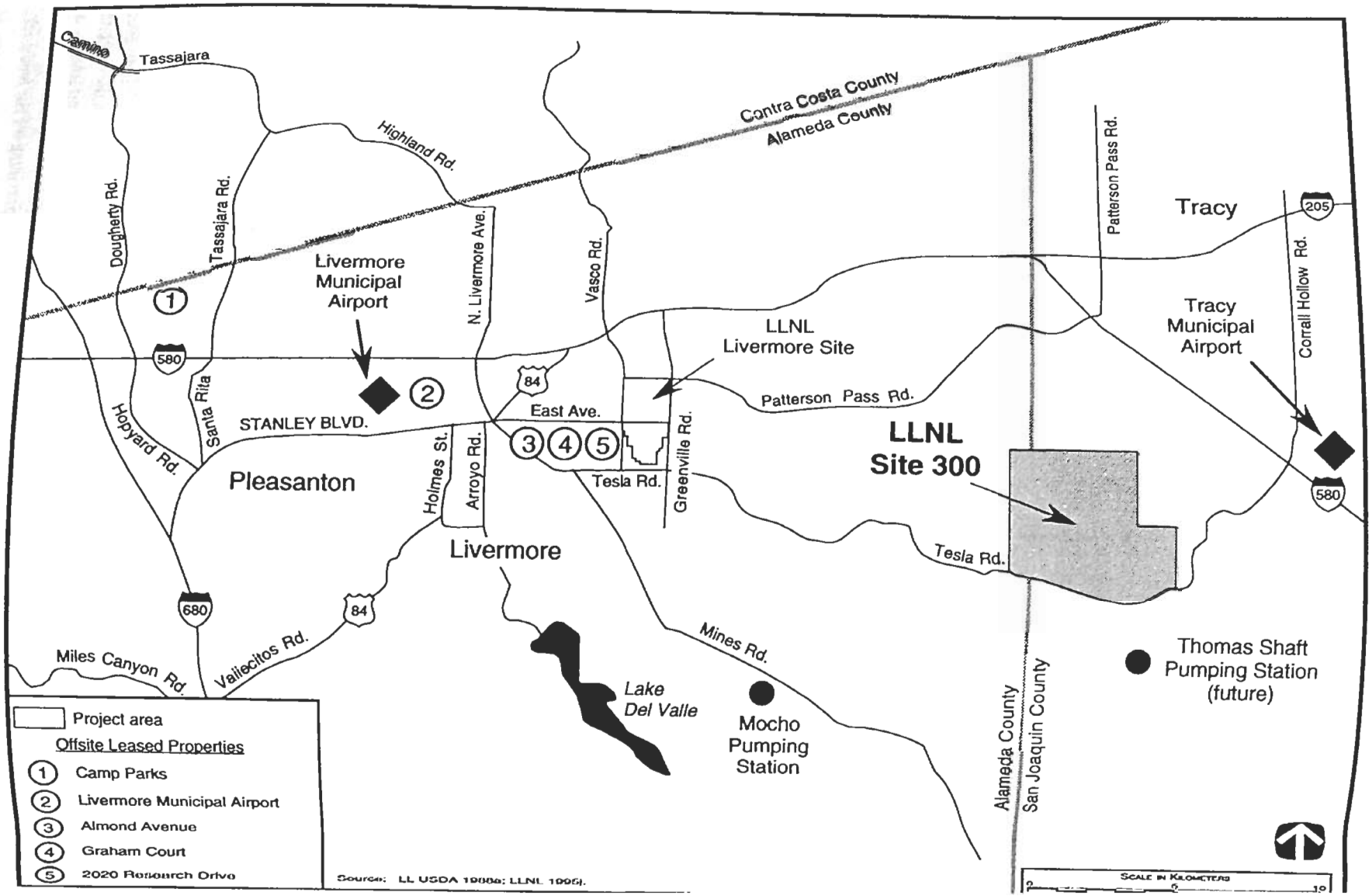

Camino
Tassajara
Contra Costa County
Alameda County
Highland Rd.
Dougherty Rd.
Tassajara Rd.
Livermore Municipal Airport
N. Livermore Ave.
Vasco Rd.
Patterson Pass Rd.
Tracy
205
Corrall Hollow Rd.
LLNL Livermore Site
Tracy Municipal Airport
580
84
Santa Rita
STANLEY BLVD.
East Ave.
Patterson Pass Rd.
Hopyard Rd.
Pleasanton
Holmes St.
Arroyo Rd.
Tesla Rd.
Greenville Rd.
LLNL Site 300
Livermore
Tesla Rd.
680
Vallecitos Rd.
Miles Canyon Rd.
Mines Rd.
Lake Del Valle
Mocho Pumping Station
Thomas Shaft Pumping Station (future)
Alameda County
San Joaquin County
Project area
Offsite Leased Properties
1 Camp Parks
2 Livermore Municipal Airport
3 Almond Avenue
4 Graham Court
5 2020 Research Drive
Source: LL USDA 1988a; LLNL 1995j.
SCALE IN KILOMETERS

TABLE A.3.5.3–1.—*Lawrence Livermore National Laboratory High Explosives Fabrication Products and Capabilities*

Products	Capabilities
High Explosives	**Manufacturing Process Development**
	Support stockpile stewardship
	Formulation
	Synthesis
	Surveillance
	Main charge manufacturing
Binders	Pressing
	Machining
	Subassembly
	Receiving/storage
	Quality assurance-mechanical/chemical/test fire
	Disposition
Main Charge Formulations	**Energetic Component Manufacturing**
	Pressing
	Machining
	Subassembly
	Quality assurance-mechanical/chemical/test fire
Initiation High Explosives	**Detonators**
Mock High Explosives Formulations	**Testing**

Source: LLNL 1995j.

main charge and component procurement, and fabrication as required by the production mission. The products and capabilities for which LLNL would be responsible are shown in table A.3.5.3–1.

Assumptions. The specific assumptions for the HE fabrication mission at LLNL are as follows:

- All production operations can be housed within existing buildings with one exception: modifications would be undertaken only when necessary or where it could be shown to be cost-effective. Modifications include moving, adding or subtracting walls, relocating existing equipment, purchasing new equipment and all associated costs.

- DOE R&D funding for present HE activities would continue at the current level in fiscal year 1995 dollars, adjusted for inflation. This includes mutually dependent R&D missions and interfacing activities. The Work for Others category of activities in energetic materials would remain at least at constant fiscal year 1995 levels and would likely increase.

- Baseline technologies would be employed except where alternatives could be shown to meet requirements and be more cost effective (i.e., faster, better, and/or cheaper). Technical shortfalls identified in the current baseline technology would be addressed with alternative technology.

- The LLNL health and safety structure is adequate to support production needs. Additional staff would be added, if required.

- The LLNL materials management infrastructure could fulfill all material, control, and accountability plus shipping and receiving requirements for the production operation. Additional staff would be added, if required.

- The LLNL waste management infrastructure is adequate to deal with any new or additional waste streams. Additional staff would be added, if required.

- LLNL has adequate safeguards and security infrastructure to deal with the production mission. Additional staff would be added, if required.

- LLNL would not store excessive quantities of conventional HE or insensitive HE. In certain cases, there would be room to expand existing storage capacities by moderate amounts, as necessary, to accommodate production throughput requirements.

- A separate management structure, capable of implementing the production operation and fulfilling all quality assurance and certification requirements, would be put in place if LLNL is selected for the HE production mission.

- A site-specific EIS would most likely not be needed to fulfill NEPA requirements for the overall production mission. The need for further NEPA documents would be assessed, as appropriate.

- The first production unit for new HE production would be October 1, 1998.

- A 27-month period, commencing July 1, 1996, would be an adequate transition time with the only exception being Pantex D&D overhead costs and safe shutdown costs.

- Dismantlement schedules would not affect first production unit for HE production.

Transition of High Explosives Fabricat Mission to Lawrence Livermore National Labo tory. LLNL maintains a full-spectrum HE RD and fabrication capability. The energetic mater program is conducted at Site 300 and in the Applications Facility at the Livermore Site. LL has maintained the ability to fabricate sizal numbers of HE components on an annual as-nee basis in support of the nuclear test schedule and support of DOD projects and missions. Assumpti of the production and fabrication of HE compone and materials mission would be a readily accomm dated incremental increase to the workload current supported by the HE technology at LLNL.

Small-scale process development/prove-in would b done at the HE Applications Facility, which meets c exceeds all applicable ES&H requirements for explo sives R&D and production support. Synthesis an formulation would be performed in this building. Th full spectrum of other HE-required activities take place here, ranging from detonator development to experiments involving 10-kg (22-lb) detonations. No significant upgrades to the HE Applications Facility would be required.

Large-scale synthesis and formulation is currently done at Site 300. The HE Applications Facility staff administers the technical work performed at Site 300 to ensure full program synergy. Thus the larger scale work at Site 300 is done in parallel with the HE Applications Facility's small-scale process development. It is not necessary to ship significant quantities of HE (>10 g) between the locations: Site 300, like the HE Applications Facility, is a fully self-contained installation. There are no public roads at the site, and population encroachment is not an issue. LLNL would be able to perform synthesis and formulation manufacturing of required energetic materials and main charge fabrication at Site 300 for the foreseeable future. Site 300 facilities contain the necessary equipment for fabrication work. Specialized equipment needed for R&D of new processes and of the next generation of explosives, which may be required by the enduring stockpile, are currently available at Site 300. For example, three deaerator loaders for injection loading of explosives that range in capacity from 50 g to 23 kg (1 ounce to 50 lb) are fully operational.

Both the HE Applications Facility and the synthesis, formulation, and production area at Site 300 have local analytical capability. To enhance capabilities in a cost-effective fashion, the HE program also extensively utilizes LLNL's main analytical laboratories. The Site 300 synthesis and formulation complex is located near the associated HE activities (e.g., the processing area, the engineering area, the radiography laboratory, the environmental test facilities, and the hydrodynamic test bunkers). LLNL analytical capabilities are such that no problems are anticipated in developing the appropriate characterization infrastructure to support the new mission. Test fire capabilities at many levels of charge size exist at Site 300 and in the HE Applications Facility.

LLNL synthesis and formulation staff with present facilities can produce plastic bonded explosives fabrication levels of 450 kg/week (1,000 lb/week) which would be sufficient to meet anticipated production requirements. There would be no facility capacity restrictions for the envisioned material quantities.

The LLNL waste minimization program has reduced the waste associated with HE manufacturing. The HE fabrication mission quantities would involve levels of HE waste generation that are well within disposal capability limits and NEPA/CEQ requirements.

Facility Description. The facility at LLNL would consist of a fabrication facility consisting of one main functional area; HE technology with four main functions: HE main-charge fabrication, small HE formulation and synthesis; and HE testing and characterization. LLNL has the facility infrastructure shown in table A.3.5.3–2 available to support the HE fabrication mission.

In addition to the facilities listed in table A.3.5.3–3 that are to be used directly in support of HE fabrication, 11,000 m^2 (119,000 ft^2) of other support facilities at Site 300 and at the Livermore Site would be available for support of HE fabrication efforts. There are also 8,600 m^2 (92,935 ft^2) of support facilities at Site 300 and at the Livermore Site. The nondestructive evaluation, chemical analysis, or characterization areas that directly support the HE effort are critically important support facilities for other LLNL missions and would remain whether or not HE fabrication is carried out as a LLNL mission.

TABLE A.3.5.3–2.—*Lawrence Livermore National Laboratory High Explosives Fabrication Facility Infrastructure*

23 buildings (Site 300 and Livermore Site)
66 magazines (200,000 lb limit)
Working space (68,000 ft^2)
Waste tanks for all buildings
Backup power for all buildings and equipment
Independent boilers for all buildings
Independent compressors for all buildings
Air exchange cycle rate of 4 per hour per laboratory
Facilities meet all DOE explosives safety requirements
Operations are fully permitted
Open burning for disposal of minimized HE waste permitted

Source: LLNL 1995j.

Design Safety. The following sections identify important safety considerations incorporated in the design of DOE facilities. Performance goals commensurate with the associated hazard are selected for all structures, systems, and components. The term "hazard" is defined as a source of danger, whether external or internal. Natural phenomena such as earthquakes, extreme winds, tornadoes, and floods are external hazards to structures, systems, and components; whereas, toxic, reactive, explosive, or radioactive materials contained within the facilities are internal hazards. The usage category is established by DOE management.

Earthquake. All existing HE plant structures at Site 300 meet all current applicable standards. New plant structures, systems, and components, when required, shall be designed for earthquake-generated ground accelerations in accordance with *Design and Evaluation Guidelines for DOE Facilities Subjected to Natural Phenomena Hazards* (UCRL-15910), with applicable seismic hazard exceedance probabilities of $2x10^{-3}$ for general use (performance category 1), $1x10^{-3}$ for low and moderate hazard (performance categories 2 and 3), and $2x10^{-4}$ for high hazard (performance category 4) structures, systems, and components.

Wind. All existing HE plant structures at Site 300 meet the wind criteria as discussed below. All new plant structures, systems, and components would be

designed for wind or tornado load criteria when required in accordance with UCRL-15910 and the corresponding facility usage and performance goals. Wind loads shall be based on the annual probabilities of exceedance of $2x10^{-2}$ for the general and low hazard (performance category 1 and 2), $1x10^{-3}$ for the moderate hazard (performance category 3), and $1x10^{-4}$ for the high hazard (performance category 4) structures, systems, and components. Wind design criteria is based on annual probability of exceedance, importance factor, missile criteria, and atmospheric pressure change as applicable to each performance (usage) category as specified in UCRL-15910.

Floods. All HE facilities and buildings at Site 300 are located above the critical flood elevation from the potential flood source (river, dam, levee, and precipitation). The extent of the flood hazard is determined, using the appropriate usage (performance) category for determining the Annual Hazard Probability of Exceedance: $2x10^{-3}$ for general use (performance category 1), $5x10^{-4}$ for important or low hazard (performance category 2), $1x10^{-4}$ for moderate hazard (performance category 3), and $1x10^{-5}$ for high hazard (performance category 4) facilities as defined in UCRL-15910.

The critical flood elevation is determined by obtaining the appropriate design basics flood level. The design basics flood level is the peak hazard level (flow rate and depth of water) corresponding to the mean Annual Hazard Probability of Exceedance or combinations of flood hazards (river flooding and wind-wave action), and corresponding loads associated with peak hazard level and applicable load combinations (hydrostatic and/or hydrodynamic forces and debris loads). LLNL site drainage conforms to the governing local agency regulations. The minimum design level for the stormwater management system is the 25-year 6-hour storm, but potential effects of larger storms up to the 100-year 6-hour storm are also considered.

Fire Protection. The fire protection features for the existing plant and its associated support buildings are in accordance with DOE orders and the National Fire Protection Association Fire Codes and Standards. A fire hazards analysis would be performed to assess the risk from fire to the HE Fabrication Facility within the individual fire areas of the facility. All fire sprinkler water that has been discharged during and after a fire would be contained, monitored, samp and, if required, retained until it could be dispose

Safety Class Instrumentation and Control. The saf classification of instrumentation and controls derived from the safety functions each performs. T safety classification is based on appropriate D(orders. HE facilities at Site 300 that utilize inst mentation for explosives operations currently m safety class requirements.

Ventilation. The heating ventilation and air cond tioning system provides environmental conditio for the health and comfort of personnel and f equipment protection.

Internal Explosion. New and existing buildings ar designed for the effects of accidental explosion within a bay or cell. The design is in accordance wit DOE/EV/06194, including the quantity-distance an the level-of-protection criteria for each class of explosives activities. Additional resource document for the siting and design of explosives facilities listed in the above-referenced manual are utilized to provide a safe design where applicable.

Safeguards and Security System Description. Site 300 is surrounded by multiple fences for security. Although not indicated on the plot plan, there are two security access areas within which various components of the HE Fabrication Facility are located: the limited area and the property protection area. The property protection area surrounds the limited area. Main-charge pressing, machining, and inspection; HE and conventional explosives shipping and receiving; and explosives storage would be performed within a limited area. Synthesis and formulation and test firing would also be performed within a limited area. Most other support facilities would be in a property protection area. All security access areas meet DOE safeguards and securities standards for the proscribed activities associated with HE main-charge fabrication and associated activities for nuclear weapons applications.

Overall Facility Layouts and Design Descriptions. The HE fabrication facilities are described in tables A.3.5.3–3, A.3.5.3–4, and A.3.5.3–5, which summarize facility data for buildings and support areas including the structure footprint area, construction material, and the security area. Structures con-

TABLE A.3.5.3–3.—*Lawrence Livermore National Laboratory High Explosives Fabrication Facility Data*

Facility Function	Building[a]	Construction Type	Footprint (m^2)	Number of Levels	Special Materials	Access Area
Main Charge Fabrication						LA
Pressing		Concrete		1	HE	
Machining	817		300			
	806		600			
	809		150			
Subassembly						
Physical prop	810		500			
	HEAF		66			
Small High Explosives Components	HEAF	Concrete	30	1	HE	LA
	826		160			
Main Charge Test Fire	851	Concrete	1,000	1	HE	LA
High Explosives Formulation and Synthesis	826		160			LA
	827A		155			
	827C		168			
	827D		168			
	827E		168			
Conventional High Explosives Storage	New	Concrete	116	1	HE	LA
Explosives Storage	854J	Concrete	500	1	HE	LA
Explosives Shipping, Receiving, and Inspection	805	Concrete	636	1	HE	LA
High Explosives Test Firing and Characterization	HEAF	Concrete	28	2	HE	LA
	222		28	1	non-HE	LA
	235		28	2	non-HE	LA
	241		9	2	non-HE	PPA
Nondestructive Evaluation	823	Steel	255	1	HE	LA
Metrology	806 (room 105)	Concrete	90	1	HE	LA

[a] High Explosives Applications Facility (HEAF) is Building 191 on the Livermore Site; all other buildings are at Site 300.
Note: LA - limited area; PPA - property protection area.
Source: LLNL 1995j.

TABLE A.3.5.3-4.—*Lawrence Livermore National Laboratory Support Facilities Description*

Facility Name	Building	Construction Type	Footprint (m^2)	Number of Levels	Special Materials	Access Area
Central shipping and receiving warehouse	875	Steel	1,380	2	None	PPA
Effluent monitoring/ meteorological tower						PPA
Facility maintenance shops	873	Steel	1,400	2	None	PPA
Vehicle maintenance facility	879	Steel	255	1	None	PPA
Fire station and security	870 and 882	Steel	557	1	None	PPA/LA
Medical center	877	Steel	310	1	None	PPA
Administration	871	Steel	930	1	None	PPA
Change house/laundry	813	Steel	262	1	None	PPA
Cafeteria	880	Steel	218	1	None	PPA
ES&H lab	222					LA
Helicopter pad						PPA
Storage yard			1,860			PPA
Parking						PPA

Note: LA - limited area; PPA - property protection area.
Source: LLNL 1995j.

TABLE A.3.5.3-5.—*Lawrence Livermore National Laboratory Support Function Facilities Description*

Facility Name	Building	Construction Type	Footprint (m^2)	Special Materials	Access Area
Plant Utilities					
Utility building	All located in General Services Area	Steel	670	None	PPA
Water storage tanks			76		PPA
Raw water supply			186		PPA
Plant water treatment			427		PPA
Tower cooling water facility			560		PPA
Firewater storage tank and pumphouse			370		PPA
Switchyard			186		PPA
Emergency generator		Steel	130	None	PPA
Diesel fuel storage			93		PPA
Nitrogen tanks			200		PPA
Waste Management					
Explosives waste management, handling, storage, and treatment	816, M1 through M5	Concrete	96	HE	PPA
			129		
Sanitary wastewater treatment	845		827		PPA
			4,645	non-HE	

Note: PPA - property protection area.
Source: LLNL 1995j.

taining explosives are generally constructed from steel-reinforced concrete and are designed to mitigate the efforts of a potential accidental explosion. Although insensitive HE materials can generally be processed in conventional steel structures, concrete construction is typically used in current facilities to maintain the flexibility to process conventional explosives. The resulting facility design typically consists of a number of separate operating bays that could vent to an unoccupied area should a detonation occur. This is true for existing buildings which meet current and anticipated explosives safety requirements. Structures that do not require concrete construction due to the presence of HE are generally constructed of steel, although portions of these buildings may be concrete. One-half of Building 875 would be used for inert storage for this mission.

High Explosives Main-Charge Manufacturing. These buildings compose the facility that fabricates main-charge hemispheres, mock main-charge hemispheres, and explosive test specimens. The various functional areas are described below:

Isostatic Pressing. Rough pressings for HE main-charge hemispheres and material test billets would be fabricated in Buildings 817A, B, C, D, E, and F, which are moderate hazard (performance category 2) facilities.

Explosives Machining. The rough pressings are machined into hemispherical shapes or test elements in Buildings 806 and 809.

High Explosives Main-Charge Subassembly. The explosive hemisphere assembly would be done in Buildings 810A and 810B.

High Explosives Shipping and Receiving. Building 805 is designed to ship, receive, and inspect HE bulk and parts (both conventional and insensitive HE).

High Explosives Storage. Building 854J comprises 378 m^2 (4,068 ft^2) and has more than adequate space available for bulk and parts storage and staging.

Conventional High Explosives Storage. A facility would be constructed at the HE storage area near M30 and M34. This 116-m^2 (1,250-ft^2) facility would have a 11,350-kg (25,000-lb) conventional HE bulk and parts storage and staging capacity.

Small High Explosives Component Fabrication. This activity fabricates small HE weapon components and test assemblies. Various small components are fabricated from HE powders and binders, metal or plastic components, electrical components, hardware, and assembly materials. The fabrication process requires equipment for explosive powder heating, pellet pressing, laser welding, ultrasonic cleaning, extrusion loading, density testing, and mechanical assembly. Functions are described below.

Pellet Pressing. Small pellets are pressed to density specifications for small energetic component assemblies in Building 191 (HE Applications Facility).

Extrusion Loading. Extrudable (paste) explosive is loaded onto small fixtures for small component assemblies in Building 826.

Small Component Assembly. Small HE pellets and/or fixtures containing extrudable paste explosive are assembled with inert parts to make small components in Building 810A.

High Explosives Formulation and Synthesis. This activity has the capability to produce a variety of explosive materials from chemical reactants and commercially produced explosives.

High Explosives Formulation. For purposes of this analysis, material lots up to about 90 kg (200 lb) are assumed to be produced through a series of batch operations in Buildings 826 and 827C, D, and E. Some products are used to make small HE weapon components while other products support the development of new explosives or explosives fabrication processes.

High Explosives Synthesis. Buildings 827C, D, and E contain a variety of vessels, filters, and transfer pumps which are used to synthesize, recrystallize, blend, and wash explosive powders. The facility also includes bays for mixing/milling, particle-size reduction, drying/weighing/packaging, solvent storage, and refrigerated storage for explosives and chemicals.

High Explosives Testing and Characterization. Explosives test configurations are assembled and detonated. The test data characterizes the explosives performance and are required for the qualification of raw materials and production lots. Testing requires

explosives containment chambers and an array of special instrumentation, including streak cameras, rotating mirror framing cameras, an air image converter system, oscilloscopes and digitizers, flash x-ray systems, and velocity interferometers.

High Explosives Test Firing. Energetic materials components are test fired at the HE Applications Facility, Building 191, at the Livermore Site. This facility has a considerable gas gun capability with 10-kg (22-lb) (trinitrotoluene [TNT]-equivalent) rated contained-firing tank. This facility has a total of six contained firing chambers which range in HE capacity from a few grams to 10 kg (22 lb) (TNT-equivalent).

The remote firing facility, Building 851 at Site 300, is remotely located from HE fabrication operations and includes an outdoor firing capability to conduct large-scale explosives tests that cannot be performed in a test chamber, such as main charges for explosives lot certification.

Nondestructive Evaluation. Building 823 is an area where explosive and inert components are inspected with radiography equipment to detect flaws, cracks, and voids.

Mechanical Properties Testing. The mechanical properties of explosive components and materials are tested in Building 191 (Livermore Site) to support lot certification for materials and components and to support fabrication development. The test configurations are assembled, and tensile and compressive tests are conducted.

Analytical and Materials Characterization Laboratories. Chemical analyses are performed on explosive and nonexplosive materials in Buildings 191, 222, 235, and 241 (Livermore Site) to determine or verify their characteristics. The data obtained yield valuable information about the condition and composition of the material. The methods used include gas chromatography, liquid chromatography, size exclusion chromatography, infrared spectroscopy (Building 222), particle characterization (Building 241), atomic spectroscopy, emission spectroscopy (Building 235), and thermal analysis (Building 191).

Material Compatibility Testing. Test coupons are assembled such that the subject materials are in direct contact with each other in Building 810A. These coupons are then placed in environmental over accelerate the aging process. Gas samples are per ically taken from the coupon containers analyzed. Compatibility testing is required to ce new materials for weapon use.

Process Support Systems. Process support for the fabrication operation includes a machine shop ES&H laboratory, as well as other plant gene services facilities. These facilities directly support HE fabrication mission, as well as existing, ongo missions such as RD&T and other activities at LL

Resource Requirements During Construction. HE fabrication operations can be housed with existing buildings except for the conventional H storage building. This building would have 11,350 (25,000 lb) conventional HE bulk and parts stora capacity and a 116 m^2 (1,250 ft^2) staging capaci The total construction requirements for materials a utilities are shown in table A.3.5.3–6. Peak constru tion year emissions and construction worker requir ments are shown in tables A.3.5.3–7 and A.3.5.3-respectively.

TABLE A.3.5.3–6.—*Lawrence Livermore National Laboratory High Explosives Fabrication Construction Materials/Resources Requirements*

Material/Resource	Total Consumption[a]	Peak Demand
Electricity (MWe)	15MWh	0.2 MWe
Water (L)	1,230,000	
Concrete (m^3)	190	
Steel (t)	15	
Liquid fuel, and lube oil (L)	9,500	
Industrial gases[b] (m^3)	3	

[a] Total construction period is 1 year.
[b] Cubic meters at standard temperature and pressure.
Source: LLNL 1995i:3; LLNL 1995j.

Resource Requirements During Operations–High Explosive Fabrication Mission. Table A.3.5.3-3 lists all the required facilities for HE fabrication operations at LLNL and the footprint or area on the ground required for each facility. Requirements to operate the LLNL HE fabrication facilities are shown in tables A.3.5.3–9, A.3.5.3–10, and A.3.5.3–11. The HE Fabrication Facility is located on approximately

TABLE A.3.5.3–7.—*Lawrence Livermore National Laboratory High Explosives Fabrication Construction Emissions*

Pollutant	Quantity (kg)
Carbon monoxide	7.3
Oxides of nitrogen	2.7
Particulate matter	0.9
Sulfur dioxide	0.23
Volatile organic compounds	1.4

Source: LLNL 1995i:3; LLNL 1995j.

TABLE A.3.5.3–8.—*Lawrence Livermore National Laboratory High Explosives Fabrication Construction Workers*

Employees	Year 1
Craftworkers	
Carpenter	3
Concrete mason	1
Electrician	1
Iron worker	1
Laborer	1
Millwright	1
Operator	1
Other craftworkers	1
Pipe fitter	1
Sheet metal worker	1
Sprinkler fitter	1
Teamster	1
Construction management and support staff	5
Total Employment	19

Source: LLNL 1995i:3; LLNL 1995j.

TABLE A.3.5.3–9.—*Lawrence Livermore National Laboratory High Explosives Fabrication Surge Operation Annual Utility Requirements*

Utility	Consumption	Peak Demand[a]
Electricity	4,300 MWh	1 MWe
Liquid fuel (L)	53,100	
Natural gas[b] (m^3)	None	
Water (L)	58,200,000	

[a] Peak demand is the maximum rate expected during any time.
[b] Cubic meters measured at standard temperature and pressure.
Source: LLNL 1995i:3; LLNL 1995j.

TABLE A.3.5.3–10.—*Lawrence Livermore National Laboratory High Explosives Fabrication Surge Operation Workers*

Labor Category	Number of Employees
Direct workers	52.5
Direct support workers	42
Operations support workers	17
Facilities support workers	8.9
Indirect support workers	112
Total	232[a]

[a] Total surge employment. Increase to current employment would be 100.
Source: LLNL 1995i:2; LLNL 1995i:3; LLNL 1995j.

2,800 ha (7,000 acres) of land at Site 300. The additional utilities and fuel required for conducting the HE fabrication mission at LLNL are shown in table A.3.5.3–9.

The facility operations required to meet the HE fabrication mission at LLNL are based on a single shift per day, 50 weeks per year, 40 hours per week, for 250 days of operational time annually. Maintenance time and scheduling for manufacturing operations would be based on equipment and facility-specific requirements and, as such, routine maintenance would be performed as needed and scheduled such that there is minimal impact to operation schedules by correlating equipment maintenance with maintenance schedules for plant activities.

The number of workers required at LLNL to accomplish the HE fabrication mission at LLNL are shown in table A.3.5.3–10.

Chemicals Consumed During Operations. The chemicals consumed during all HE fabrication operations at LLNL are shown in table A.3.5.3–11. The HE fabrication operations do not require radiological materials and no workers would be exposed to radiation under normal operations.

Emissions During Operations. The additional emissions that would result from accomplishing the HE fabrication mission are shown in table A.3.5.3–12.

Waste Management. The liquid and solid waste streams generated by the HE fabrication mission

TABLE A.3.5.3–11.—*Lawrence Livermore National Laboratory High Explosives Fabrication Sur Operation Annual Chemical Requirements*

Chemical	Quantity (kg)	Chemical	Quantity (kg)
Acetone	227	Helium	45
Acetonitrile	91	Heptane	45
Activated charcoal	45	Hydraulic/lubricating oil	908
Adiprene polyurethane composition	45	Hydrochloric acid	68
Aluminum metal	454	Joint compound	45
Ammonia	454	Kimwipes	908
Aqueous film forming foam	91	Micro liquid lab cleaner	5
Circlene Fg 20	91	Mild steel metal	454
CLEPOX 143	91	Molecular sieve	45
Copper/CuO wire	9	Neutrasorb acid neutralizer	45
Copper metal	23	Nitrogen	227
Cyanuric acid	45	Paint	454
Degreaser	5	PLANISOL-M concentrate	23
Desiccants	91	Polyalkylene and ethylene glycol	14
Dispersant	23	Potassium hydroxide	45
Dry air	136	Silicone elastomer	91
DUST-OFF	23	Siliconized ammonium phosphate base	5
ECO-STAR	23	Sodium hydroxide	45
Electrode/probe solutions	23	Solksorb solvent absorbent	227
Ethyl alcohol	91	Sulfuric acid	23
Ethyl acetate	136	TALC	5
Fixer and replenisher	91	Tetrahydrofuran	227
Glass cleaner	45	TISAB with CDTA	14
Glass beads	145	Toluene	227
Glycerine	68	Toner	23
HE powders, insensitive	54,432	Trichlorotrinitobenzene	23
HE powders, conventional	18,144	Water treating chemicals	91

Source: LLNL 1995i:3; LLNL 1995j.

would be processed to meet Federal, state, and DOE requirements for the various types of nonhazardous, hazardous, and radioactive wastes. Waste management facilities and assets would be used to receive, track, characterize, treat, package, store, and ship wastes generated by HE fabrication. Facilities would include a waste management operation, waste storage facility, sanitary wastewater treatment unit, and a sanitary and industrial landfill.

Nonhazardous waste generated at the HE Fabrication Facility would consist primarily of solid sanitary waste, sludge from sanitary wastewater treatment, maintenance residues, and scrap parts. Materials unsuitable for recycling would be disposed of appropriately. Liquid sanitary wastes would be collected by independent underground septic tanks at HE fabrication buildings and by sewer pipe systems from most of the support buildings in the General Services Administration area and routed to the domestic sewage lagoon for evaporation and percolation. Excess water would be discharged to a natural drainage channel. Sewage sludge would be disposed of in offsite sanitary and industrial landfills. Process wastewater would be sent to holding tanks for treatment and recycling, where appropriate. Stormwater from all areas of Site 300 would go into natural drainage channels. Nonhazardous rinsewater from

TABLE A.3.5.3–12.—*Lawrence Livermore National Laboratory Incremental Annual Emissions During Operations*

Pollutant	Quantity (kg)
Criteria Pollutant	
Carbon monoxide	1,315
Nitrogen oxides	349
Ozone (as VOC)	45
Particulate matter	27
Sulfur dioxide	24
Hazardous and Other Toxic Compounds	
Ammonia	4.5
Acetonitrile	14
Bisphenol alpha epichlorohydrin	0.5
Benzene	0.2
Chloroform	0.5
Cresylic acid	0
Cyclohexane	0.5
Dibutyl phthalate	0.05
1,2-Dichloroethane	0.9
Dimethyl formamide	0.5
Dioxane	0.5
Ferric ferrocyanide	0
Hexane	0.5
Hydrogen chloride	11.3
Hydrogen fluoride	22.7
Hydrogen sulfide	0.2
Mercury	0
Methanol	4.5
Methyl ethyl ketone	22.7
n-Butyl glycidyl ether	0.2
Propylglycol methyl ether	0.5
Toluene	2.3
Trichloroethylene	0.2
Triethylamine	0.2
2,2,4-Trimethyl-1, 3-pentane-diol isobutyrate	0.5
Xylene	2.3

Source: LLNL 1995i:3; LLNL 1995j.

HE formulation and machining operations is discharged to a surface impoundment for evaporation.

Hazardous wastes generated by the HE fabrication mission would consist of solid residue from thermal treatment (open burning) of scrap explosives and explosives-contaminated combustible materials. This residue and other hazardous wastes, such as waste oils and paint residues, would be properly packaged and managed for offsite treatment and disposal at RCRA-permitted facilities.

HE residual materials such as bulk HE machining scrap and off-specification HE components and HE-contaminated materials, including gloves, wipes, rags, and process water generated during HE fabrication operations, would be the source of most of the waste material that would be processed. Waste minimization and recycle processes would be used to reduce the amounts of material that ultimately must be subjected to waste treatment processes. Scrap HE and HE-contaminated process water that are recycled are not considered waste and would be handled as in plant operations.

Currently, thermal treatment of HE and HE-contaminated materials (open air burning) is the preferred permitted technique used to dispose of and decontaminate solid materials. Next generation, more environmentally benign destruction technologies are being developed and would be incorporated when available and appropriate.

HE-contaminated process water generated by synthesis and formulation processes, and vacuum pump seal water would be collected in tanks and analyzed for appropriate waste classification and then disposed of as appropriate. Water from HE machine processes would be filtered through a weir and clarifier system and then discharged to holding ponds. Sanitary wastewater would be collected in a separate system and routed to septic tanks or sanitary wastewater treatment facilities. Stormwater would go into natural drainage channels at Site 300.

The utilities required for operation of waste treatment functions associated with the HE fabrication processes would include water, electric power, liquid fuels, steam, compressed air, and propane gas. These utilities are also used in normal HE plant operations and would not pose any significant increase in consumption nor any unique requirements.

The wastes and emissions generated during HE fabrication waste treatment operations would include gaseous decomposition products of combustible materials, hazardous solid waste, and nonhazardous

solid and liquid wastes. Hazardous wastes consisting of solid residue (ash) from the thermal treatment process would be characterized, packaged, and sent to an approved RCRA-permitted disposal site. Nonhazardous wastes generated by HE fabrication would consist of solid sanitary waste, sludge from sanitary wastewater treatment, and other noncombustible parts. Materials that cannot be recycled would be sent to an approved landfill.

All operations involving HE must comply with DOE/EV.106194 and meet explosives safety requirements. Buildings must meet blast-resistant building construction standards and quantity-distance criteria. A capability for remote operations would also be necessary for disposal processes. The design would incorporate spill-prevention control and countermeasure elements.

The Livermore Site and Site 300 waste management facilities to support the HE fabrication mission include:

- The waste management facility, which provides space and equipment for receiving, tracking, packaging/repackaging, and shipping of solid and liquid wastes. Areas are segregated by waste type. Operating areas are provided for waste staging and container storage.

- The waste storage facility, which stores hazardous waste for up to 1 year of operation prior to offsite treatment/disposal. An explosive waste storage facility is currently being constructed and permitted to manage explosive wastes. Storage and staging areas are segregated by waste type. Equipment and design features are provided for handling drums, controlling spills, and monitoring.

- The open burn facility, which treats scrap explosives and explosive-contaminated combustible material. Plans and permits are being pursued for a new open burn and open detonation facility to treat high explosives.

- The Livermore Site, which has the ability to handle and store mixed and LLW wastes, and the HE Fabrication Facility would have the ability to handle these types of wastes if required.

- The HE fabrication facilities, all of which have a septic tank system. Industrial wastewater would be placed in holding tanks for chemical analysis to determine proper disposal method. Nonhazardous HE rinsewater is disposed of onsite in a permitted surface impoundment. Other liquid industrial wastes are shipped offsite for disposal.

Table A.3.5.3–13 lists the incremental quantities the types of wastes that would be generated at LLN to accomplish the HE fabrication mission.

Transportation. Transportation requirements exi at both the Livermore Site and Site 300 (intrasite) a between the HE Fabrication Facility and the A/D s (intersite).

Intrasite Transportation. Transportation of produc within the HE Fabrication Facility would b performed by LLNL transportation, meeting a applicable DOT and DOE criteria for transportatio of the energetic materials. Transportation of classi fied products within the HE Fabrication Facilit would be performed by LLNL transportation whic meets DOE safeguards and security criteria for trans porting classified products. Subsequent movement of HE and explosive products would be performed b vehicles specifically designed for this purpose. Th quantity of HE (conventional and insensitive) trans ported onsite by these trucks would be strictly limited. HE products would be transported by appro priate vehicle to an HE staging area for eventual recycle or disposal onsite. HE waste would be col lected, transported, and disposed of, as appropriate, for explosives materials.

Intersite Transportation. Transportation of the products from the HE Fabrication Facility would be performed by commercial vendors that meet all applicable DOT and DOE criteria for transportation of the specified materials. Transportation of classified products from the HE Fabrication Facility to the A/D plant would be performed by commercial vendors that meet DOE safeguards and security criteria for transporting these classified products, as well as DOT

TABLE A.3.5.3–13.—*Lawrence Livermore National Laboratory High Explosives Fabrication Waste Volumes*

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations (m^3)	Annual Volume Effluent from Surge Operations (m^3)
Low-Level			
Liquid	None	None	None
Solid	None	Minimal	Minimal
Mixed Low-Level			
Liquid	None	None	None
Solid	None	None	None
Hazardous			
Liquid	1	3	3
Solid	2	54	54
Nonhazardous (Sanitary)			
Liquid	454	7,270	7,250[a]
Solid	11	69	55[b]
Nonhazardous (Other)			
Liquid	946	568	566
Solid	8[c]	36	20

[a] Assumes 350:1 wastewater to sludge ratio for treatment of liquid sanitary waste.
[b] Assume 2/3 of solid is compactible by a factor of 4:1.
[c] Includes 7.6 m^3 (9.9 yd^3) of concrete and 3 t (3.3 tons) of steel which is recycled.
Source: LLNL 1995i:3; LLNL 1995j.

requirements for safe packaging and shipping of HE products. Other inert or ancillary materials that would require transportation would also be transported by qualified commercial vendors.

A.3.6 Nonnuclear Fabrication

The nonnuclear fabrication function provides the capability to fabricate nonnuclear components and perform nonnuclear component surveillance. Nonnuclear component products and/or processes fall within the groupings of those manufactured onsite and those procured. Several common subgroups have been identified:

- System Level: e.g., firesets and radars
- Electrical Components: e.g., integrated circuits and semiconductors, interconnect cables, and passive components
- Mechanical Components: e.g., radio frequency and multipin connectors, Rolamites, actuator assemblies, and reservoirs and valves
- Materials and Explosives: e.g., nuclear grade steel and molded plastic parts

The following discussion briefly describes the site alternatives for the nonnuclear fabrication mission:

Kansas City Plant. This alternative consists of three major factories involved in electronics and mechanical and engineered materials product lines, as well as outsourcing some components. KCP would downsize but maintain all of its current missions, reducing the KCP footprint to 167,000 m^2 (1.8 million ft^2) for DP activities from the current 297,000 m^2 (3.2 million ft^2). Estimated start would be in April 1998 with steady-state operation proposed in October 2003.

Los Alamos National Laboratory. This alternative is based on the use of existing facilities which are organized into a plastics facility, a pilot plant, a detonator facility, and a reservoir/valve/steel facility. The mission would be to provide high energy detonator inert components and fabrication of reservoirs, valves, and nuclear grade steel. Construction could begin in fiscal year 2000 with steady-state operation starting in fiscal year 2003.

Lawrence Livermore National Laboratory. This alternative has LLNL fabricating nuclear system plastic components, instead of LANL. The LL nonnuclear manufacturing facility would provide plastic components and polymers currently produc at KCP, including filled and unfilled molded par syntactic, rigid, and flexible foam parts; compos structures; and specialty polymers current produced at the KCP pilot plant. The 7,200-n (77,840-ft^2) facility would be housed in five existi buildings in a limited access area at LLNL. Constru tion would begin in fiscal year 1998 with steady-sta operation starting in fiscal year 2003.

Sandia National Laboratories. This alternativ would transfer the majority of current KCP mission to SNL, except for nuclear system plastic components and high energy detonator inert components SNL could also fabricate reservoirs, valves, and nuclear grade steel instead of LANL. This alternative requires both modification of existing facilities and construction of new facilities. Depending on the specific approach, total area affected would range from 56,100 to 63,200 m^2 (605,000 to 680,000 ft^2), new construction would range from 33,900 to 58,100 m^2 (365,000 to 625,000 ft^2), and modifications would range from 5,000 to 22,000 m^2 (55,000 to 240,000 ft^2). Construction would begin in the first quarter of fiscal year 1998 with steady-state operation starting in the first quarter of fiscal year 2004.

A generic set of products and services required to produce a typical bomb or re-entry warhead was defined to provide a common basis for estimating. Current program look-alikes were established to determine the standard hour content of manufactured product, productive material costs, and the cost of procured components and services. Minimum quantities per year were developed to maintain a production capability for "in-house" manufactured product.

A make-buy determination was made for each product or service (see table A.3.6–1). KCP, SNL, LANL, and LLNL used the make-buy analysis to define the manufacturing area requirements, the direct and indirect support staff, the infrastructure support staff, and productive material cost required to support anticipated production requirements. The capacity of this basic capability supports all current schedules and anticipated retrofit needs.

TABLE A.3.6–1.—*Nonnuclear Fabrication Production Products Make/Buy Matrix* [Page 1 of 4]

Product	KCP Fabricate	KCP Procure	SNL Fabricate	SNL Procure	LANL Fabricate	LANL Procure
WES/AF&F	X		X			
Firesets	X		X			
Printed wiring boards		X		X		
Printed wiring assemblies	X		X			
Multichip modules	X			X		
Hybrid microcircuits	X		X			
Housings (buy casting, forging, or bulk)	X	X	X	X		
Electronic components		X		X		
Radars (like firesets)	X		X			
Antennas		X		X		
Nose assemblies	X		X			
Electrical component assemblies	X		X			
Lasers and electro optics		X		X		
Programmers	X		X	X		
Filter packs		X		X		
Voltage regulators		X		X		
Accelerometers/ Environmental Sensing Devices	X		X			
Interconnect/junction boxes		X		X		
Preflight controllers	X		X			
Ready-safe switches		X		X		
Option select switches		X		X		
Coded switches	X		X			
Trajectory Sensing Signal Generators	X		X			
Piezoelectric motors		X		X		
Relays		X		X		

TABLE A.3.6–1.—*Nonnuclear Fabrication Production Products Make/Buy Matrix* [Page 2 of 4]

Product	KCP Fabricate	KCP Procure	SNL Fabricate	SNL Procure	LANL Fabricate	LANL Procure
Output switches	X		X			
Category F - cases and electronics assemblies	X		X			
Timers	X					
Connectors		X	X			
Lightning arrester connectors	X	X		X		
Strong links	X		X			
Actuator assemblies		X		X		
Detonator cables	X	X	X			
Interconnect cables				X		
Flat flex		X			X	X
Fiber optic		X		X		
RF and coaxial		X		X		
High voltage		X		X		
CF round wire		X		X		
Valves	X			X		
Reservoirs	X		X			
Major mechanical parts	X		X		X	
Molded plastic parts		X	X		X	
Transfer molded		X		X		
Compression molded		X		X		
Injection molded		X		X	X^a	X^a
Machined		X		X	X^a	X^a
Cushions		X		X	X^a	X^a
RTV	X				X^a	X^a
Cellular silicone	X				X^a	
Foam supports	X				X^a	
Syntactic supports	X		X		X^a	
Filled polymers	X		X		X^a	
Desiccants	X				X^a	
Getters	X		X		X^a	
			X			

TABLE A.3.6–1.—*Nonnuclear Fabrication Production Products Make/Buy Matrix* [Page 3 of 4]

Product	KCP Fabricate	KCP Procure	SNL Fabricate	SNL Procure	LANL Fabricate	LANL Procure
Parachute assemblies		X		X		
Hand T gear		X		X		
Trainer hardware and kits		X		X		
Retrofit kits		X		X		
D/855	X		X			
Joint test assemblies	X	X	X	X		
Transducers/detectors	X	X	X	X		
Data and flight recorders	X	X	X	X		
Special design hardware	X	X	X	X		
Commercial hardware		X		X		
Transportation Safeguards Division-Safe Secure Trailers	X	X	X	X		
Trailers	X	X	X	X		
Escort vehicles	X	X	X	X		
TC firing systems		X		X		
D/50 reprocessing	X		X			
Services-DOE and/or product required						
Test equipment field support	X		X			
Storage	X		X			
Testers	X		X			
Tools	X		X			
Gauges	X		X			
Data/records	X		X			
Material	X		X			
Boron reclamation/certification/storage	X				X	
Polymer pilot facility	X				X[a]	

TABLE A.3.6–1.—*Nonnuclear Fabrication Production Products Make/Buy Matrix* [Page 4 of 4]

Product	KCP Fabricate	KCP Procure	SNL Fabricate	SNL Procure	LANL Fabricate	LANL Procure
Cellular silicone compounding	X				X[a]	
Classified automated data processing	X		X			
Logistics and manufacturing center	X		X			
Test equipment maintenance	X		X	X		
Transportation containers	X	X	X	X		
Tool and gauge fabrication	X	X	X	X		
Tool and gauge design	X	X	X	X		
Test equipment design and fabrication	X	X	X	X		
SECOM	X		X			
Nuclear grade steel acceptance/storage	X		X		X	
Kirtland operations	X		X			

[a] LLNL is an alternative site for production of nonnuclear plastic components.

Source: KC ASI 1995a; LANL 1995c; LLNL 1995f; SNL 1995e.

A.3.6.1 *Downsize at Kansas City Plant*

KCP provides most of the nonnuclear components for the current nuclear weapons stockpile. KCP can effectively support the future stockpile management missions of the nuclear weapons program through a major downsizing of the physical plant and the functions required to support the production mission. The plant was designed, sized, and organized around the mission and workload of the Cold War era, and thus is not appropriately structured to efficiently accomplish the reduced workload of the future. The consolidation of the physical plant would allow a much more efficient organizational approach to be implemented to provide required direct and indirect support functions. The downsized plant would be referred to as KCP II.

The proposed KCP II consists of changing the existing plant and operational approach in four major aspects: (1) physically reducing the size of the facility, (2) changing the approach to manufacturing from product-based to process-based, (3) reducing the support infrastructure appropriate for the right-sized operation, and (4) changing the basic organizational structure to focus directly on the core manufacturing mission.

The proposed KCP II concept was developed to accommodate current and future active stockpile needs. The KCP II facility is to provide, with a 3-year notice, any conceivable combination of components for 150 factory retrofits as well as 150 field retrofits per year on a single-shift basis. These requirements are in addition to limited-life component exchanges, the stockpile evaluation program, and the stockpile surveillance program (joint test assemblies and warhead rebuild) currently scheduled.

Currently KCP consists of approximately 297,000 m^2 (3.2 million ft^2) of space contained in three connected buildings: the Main Building, the Manufacturing Support Building, and the Technology Transfer Center (figure A.3.6.1–1). Much of this floor space is underutilized and very costly to maintain. Many of the production departments are staffed with only a few people because of the low workload in some production technologies. The KCP II proposal and earlier independent space consolidation initiatives would reduce the size of the plant to approximately 167,000 m^2 (1.8 million ft^2) for DP activities. The Technology Transfer Center and Manufacturing Support Building facilities would be vacated of DP activities. All operations and support functions required for stockpile management would be accomplished within reduced floor space of the main buildings.

The KCP II proposal is based on the consolidation of similar processes in three separate production areas (the electronic, mechanical, and engineered materials factories) and several product-based departments.

Electronics Factory. The products described in this section consist of electronic systems and electrical subsystems that function within weapon systems. There are three process modules: microelectronics, interconnects, and final assembly. Table A.3.6.1–1 shows the major processes within each of the electronics modules and the product types produced by these procedures. Total production floor space requirement would be approximately 12,454 m^2 (134,000 ft^2).

Microelectronics. A significant portion of the microelectronics fabrication would be performed in an existing hybrid microcircuit production facility. This 2,970-m^2 (32,000-ft^2) facility is divided into a number of sub-areas. Some of these areas have unique cleanliness capabilities from Class 100 to Class 10,000. The facility is also designed to provide differing temperature and humidity controls, as required, for the various areas. The balance of the microelectronics fabrication would be performed 1,282 m^2 (13,800 ft^2) of the Electronics Factory Mezzanine.

Interconnects. The area for this work would occupy 2,304 m^2 (24,800 ft^2) of the Electronics Factory Mezzanine. It would include an environmentally controlled photo-imaging area and an etching area to support flat flex cables for detonator assemblies. The remaining areas would be temperature and humidity-controlled, consistent with traditional electronics manufacturing requirements.

Final Assembly. The area for this work would occupy 3,019 m^2 (32,500 ft^2) and, with one exception, would also reside on the Electronics Factory Mezzanine. The one exception would be for nose assemblies, which would be built on the factory floor near the

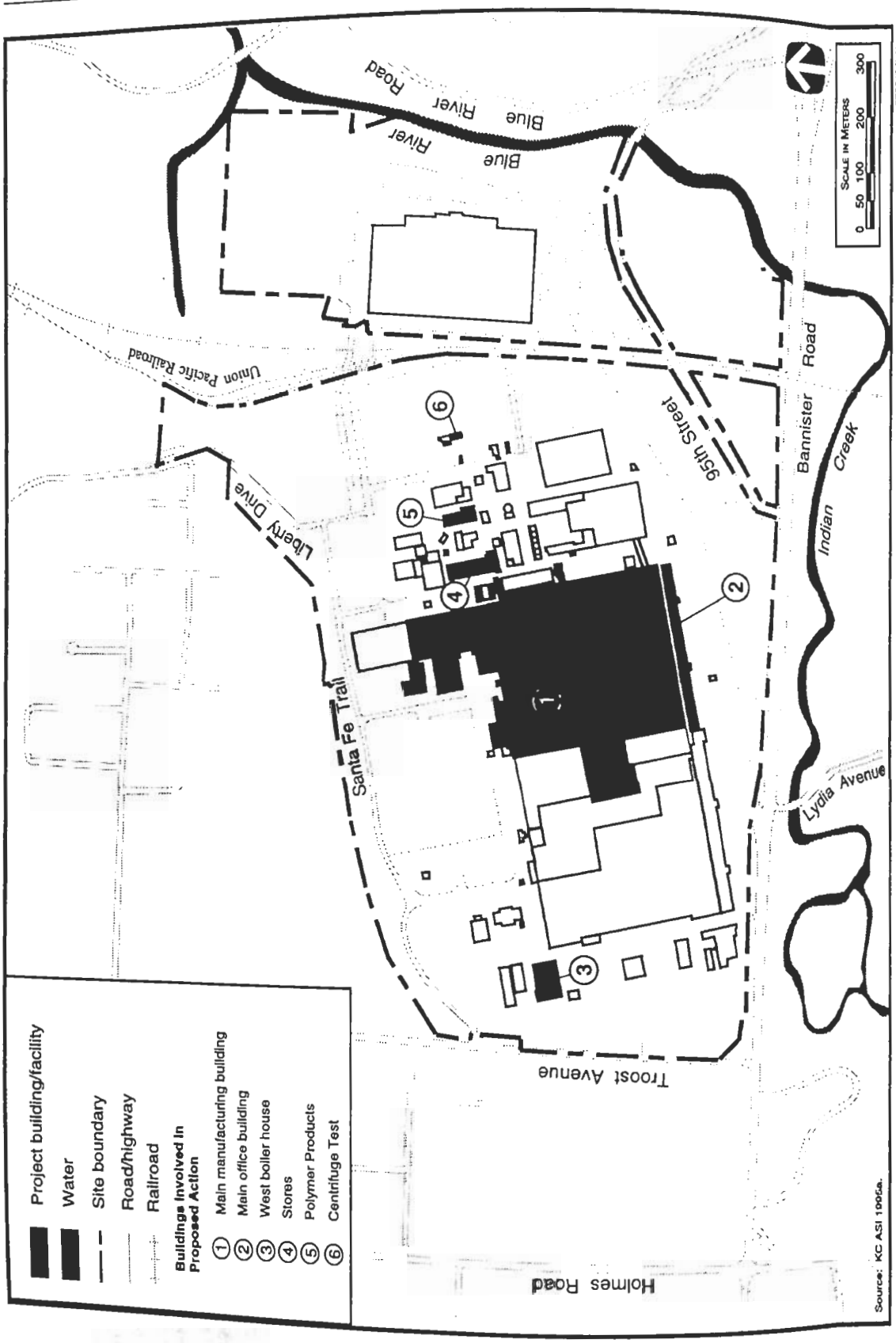


FIGURE A-3.6.1-1.—*Location of Downsized Nonnuclear Fabrication Facilities at the*

TABLE A.3.6.1–1.—*Kansas City Plant II Electronics Factory Processes and Products*

Process Module	Major Processes	Product Types
Microelectronics	Vacuum deposition	Leadless chip carriers
	Plating	Thick film networks
	Screen printing	Thin film networks
	Photo lithography	Multichip modules
	Beam lead bonding	Hybrid microcircuits
	Fine wire bonding	
	Soldering	
	Component placement	
	Hermetic sealing	
	Cleaning	
Interconnects	Manual soldering	Printed wiring assemblies
	Wave and drag soldering	
	Auto component placement	
	Component insertion	
	Robotic tinning and preforming	
	Cleaning	
	Electrical testing	
	Photo imaging	Flat flex cables
	Etching	Detonator cables and assemblies
	Laminating	
	Lead titanate processing	Lightning arrestor connectors
	Manual assembly	
Final assembly	Manual assembly	Nose assemblies
	Hand soldering	Radars
	Welding	Firesets
	Encapsulation	Arming, fusing, and firing assemblies
	Bonding	ECA's
	Cleaning	Programmers
	Electrical testing	Timers
		Controllers
		Trajectory sensing signal generators
		Code activated processes

Source: KC ASI 1995a.

new microelectronics facility. The welding and encapsulation area would support all of the weapon electronics products, as well as some joint test assemblies, special electronic assemblies, and mechanical product requirements. Temperature and humidity controls for traditional electronics manufacturing would also be provided. Products currently fabricated in-house, but to be purchased as a result of KCP II consolidation are printed wiring boards, junction boxes, antennas, voltage regulators, interconnect cables (round coaxial wire, high voltage), ready-safe switches, filter packs, and option select switches.

Joint Test Assembly/Special Electronic Assembly Factory. Security, production, and quality requirements of the joint test assembly and special electronic assembly product lines are not conducive to integration with other factory areas. Products built within the joint test assembly and special electronic assembly are primarily electronics operations and use similar or identical processes. These are bonding, cleaning, coating, encapsulation, mechanical assembly, soldering, swaging, and electrical verification.

Since the joint test assembly mission supports weapons throughout their life in the stockpile, the product lines within the joint test assembly area are somewhat insensitive to changes in weapon production requirements. As a result, reductions in the joint test assembly area would not be as dramatic as in other factory estimates. For future capacity requirements, the joint test assembly operation would be sized to produce assemblies at a rate that would support stockpile evaluation schedules currently in planning for the enduring stockpile.

The current joint test assembly production area would shrink by 33 percent to 1,644 m^2 (17,699 ft^2) (excluding stores and storage). The special electronics assembly manufacturing area would be reduced by 55 percent to 1,352 m^2 (14,550 ft^2). The joint test assembly area would be relocated to the Electronics Factory Mezzanine, while the special electronics assembly operation would be downsized in place. The estimated reduction in floorspace would primarily result from the elimination of capital equipment, testers, and tooling that are unnecessary to support the baseline workload. No special environments or highly hazardous operations would be required as a part of the production processes.

The joint test assembly operation is a job shop environment which makes use of a very limited amount of highly automated assembly, cleaning, and soldering processes. Prior to the relocation of the area, the newer products requiring automated processes would be built. At the end of that period, related test equipment and capital equipment would be moved and requalified over an 8-month period. In the interim, the labor force would be directed to build those assemblies requiring only manual soldering and cleaning techniques. Phasing production by program and process would result in a negligible increase in cost. Based on past precedent, a requalification of each product would be unnecessary since most production processes are manual and the quality of joint test assembly products is controlled primarily by the operator.

The planned special electronic assembly operation rearrangement would keep critical manufacturing equipment in place. Process requalifications would be unnecessary.

Mechanical Factory. The proposed Mechani Factory would maintain most of the capabilit presently available with significantly reduc capacity. The factory is based on projected product rates for reservoirs, transportation safeguards divisi products, and a small quantity of other unschedul production requirements. This workload exercis key factory capabilities and maintains the ability support currently unscheduled stockpile replacem product. Total productive floor space requireme would be 20,900 m^2 (225,000 ft^2).

The workload mandates the consolidation of sever previously separate manufacturing departments. Th rearrangement consolidates all general machinin processes in a common area. These consolidation allow for enhanced utilization of floor space, equip ment, and personnel. Table A.3.6.1–2 lists mechan cal factory products.

Engineered Materials Factory. The Engineered Materials Factory is designed to accommodate the minimum manufacturing capabilities required to support current and anticipated weapon program needs for all nonmetallic products. Basic processing capabilities have been retained to produce the following product families: polyurethane foam supports, syntactic foams, cushions, filled polymers, secure container assemblies, desiccants and getters, nonmetallic machining, and the polymer pilot plant. The minimum complement of manufacturing equipment to produce these products was determined and each production area sized appropriately.

Current manufacturing floor space of 11,241 m^2 (121,000 ft^2) within the main building would be reduced by more than 34 percent to 7,350 m^2 (79,150 ft^2). The polymer plant, a stand-alone facility used to produce unique materials not available from commercial suppliers, would not be reduced. Individual modules are described below:

- Compounding–164 m^2 (1,767 ft^2): This area supports the compounding of polymeric materials for urea-filled cellular silicone cushion material and metal-filled polymers for fabrication.

- Foam molding–492 m^2 (5,300 ft^2): Specially formulated polyurethane

TABLE A.3.6.1–2.—*Kansas City Plant II Alternative Mechanical Factory Products*

Area	Products
Transportation safeguards products	Safe secure trailer/safeguards transport roadworthy refurbishment
	Safe secure trailer/safeguards transport retrofit/upgrades
	Safe secure trailer decommissioning
	Escort vehicle production
	Miscellaneous trailer production/repair
Metal machining	**Metal parts to support:**
	Mechanical assembly
	Electrical assembly
	Joint test assembly
	Cases and structural parts (limited)
Sheet metal and support processes	**Sheet metal parts to support:**
	Mechanical assembly
	Electrical assembly
	Liners and housings
	Support processes:
	Plating
	Painting
	Heat treatment
Mechanical welding	Support of mechanical assembly and sheet metal
Model shop/tool support	Tool repair and emergency fabrication
	Capability for prototype and evaluation hardware

Source: KC ASI 1995a.

materials are mixed, poured, and cured to form structural parts for component packaging.

- Pressing—2,075 m^2 (22,335 ft^2): This facility molds-to-size all cushion and filled polymer products. Press capacity ranges from 9 to 1,814 t (10 to 2,000 tons).

- Machining—823 m^2 (8,864 ft^2): This environmentally controlled temperature and humidity area provides the capability to machine all nonmetallic products to their final configuration. Fabrication of syntactic foam products is also accomplished in this area.

- Assembly—2,404 m^2 (25,881 ft^2): This area supports lay-up, wrapping, and impregnating capabilities to manufacture secure container assemblies. Desiccant and hydrogen getter materials are blended, formed, and assembled in this facility.

- Polymer production—1,394 m^2 (15,000 ft^2): This external facility provides the polymer reactor capability to blend polyurethane materials that are unavailable from commercial suppliers. This facility has the capability to repackage bulk material into smaller unit quantities for production use.

Special environmental requirements were defined for machining, foam molding, and secure container assemblies, and appropriate areas were sized within the capability footprint of each module. Special security classification needs of secure container assemblies, cushion, and filled polymers have been considered and sufficient isolation provisions have been incorporated into the new factory concept.

Outsourcing Kansas City Plant-Made Products. A key tactic of the KCP II alternative is to aggressively pursue the outsourcing of products currently manufactured within KCP. KCP currently maintains most of the manufacturing technologies required to support weapons production. Anticipated reductions

in production schedules and funding will no longer support maintaining all of these technologies in-house. Outsourcing is the preferred alternative as product designs become more compatible with commercial industry capabilities. Products to be outsourced are antennas, interconnect cables, retrofit kits, filter packs, molded plastic parts, trainer hardware, voltage regulators, parachute assemblies, piezoelectric motors, junction boxes, handling equipment, TC firing sets, ready-safe switches, test gear, printed wiring boards, option select switches, trainer kits, lasers/electro-optics, and actuator assemblies.

Facilities modification to establish the KCP II configuration would take approximately 4 years. The following list describes the facility modification required to accomplish the proposed plant consolidation:

- Design and construction of standard manufacturing facilities
- Installation of modular clean rooms
- Design and construction of a fire-rated wall separating DOE from other site occupants
- Installation of heating, ventilation, and air conditioning systems and controls
- Extension of existing utility systems for chilled water, steam, sanitary, and industrial drains, and other mechanical and electrical services
- Site preparation, modification, and installation of walls and partitions, floor and ceiling finishes, security and fire protection features, and material handling equipment
- Rearrangement of existing operations and relocation of production equipment

Materials/resources consumed during KCP II construction are listed in table A.3.6.1–3. Emissions during construction/plant reduction would be negligible. The numbers of KCP II alternative construction workers required for construction/plant reduction can be found in table A.3.6.1–4.

TABLE A.3.6.1–3.—*Kansas City Plant II Construction/Plant Reduction Materials/Resources Requirements*

Material/Resource	Total Consumption	Peak Demand
Electricity	Negligible	Negligible
Concrete (m^3)	286	
Structural steel (t)	220	
Water	Negligible	

Source: KC ASI 1995a; KCP 1995a:2.

TABLE A.3.6.1–4.—*Kansas City Plant II Construction/Plant Reduction Construction Workers*

Employees	1998 Year 1	1999 Year 2	2000 Year 3	2001 Year 4	Total
Total craftworkers	87	162	104	40	393
Construction management and support staff	15	25	18	8	46
Total Employment	102	187	122	48	459

Source: KC ASI 1995a.

KCP is completing an extensive renovation and upgrade of the plants major utility systems through the facilities capabilities assurance program. KCP has upgraded the high voltage electrical distribution systems including the replacement of approximately 50 substations and switchgear and 13,800 volt cables. In addition, the majority of the roof mounted air-handling units, dehumidification units, controls and duct work, chillers and cooling towers at the west boilerhouse have been replaced. Sprinklers and fire main systems have also been upgraded to provide continued reliable fire protection for KCP. KCP manages two boiler and chiller sites on a 7-day-per-week, 24-hour-per-day basis. These locations provide chilled water, steam, and compressed air for KCP and the other Federal agencies occupying the site.

Taking the renovation and upgrade activities into account, downsizing and reconfiguring the plant for KCP II would have no impact on the utility system capacities. KCP II alternative surge operation utility requirements are shown in table A.3.6.1–5.

TABLE A.3.6.1–5.—*Kansas City Plant II Nonnuclear Fabrication Surge Operation Annual Utility Requirements*

Utility	Consumption	Peak Demand[a]
Electricity	225,000 MWh	30 MWe
Liquid fuel (L)	0	
Natural gas[b] (m^3)	18,900,000	
Raw water (dry site) (L)	1,340,000,000	

[a] Peak demand is the maximum rate expected during any hour.
[b] Cubic meters measured at standard temperature and pressure.
Source: KC ASI 1995a; KCP 1995a:2; KCP 1995a:3.

KCP II alternative operation annual chemical requirements are listed in table A.3.6.1–6, and KCP II alternative surge operation emissions are listed in table A.3.6.1–7.

TABLE A.3.6.1–6.—*Kansas City Plant II Nonnuclear Fabrication Surge Operation Annual Chemical Requirements*

Chemical	Quantity
Nitrogen	
Gas (m^3)	3,270
Liquid (L)	14,900,000
Argon	
Gas (m^3)	4,830
Liquid (L)	236,000
Carbon Dioxide	
Gas (m^3)	322
Liquid (L)	122,000
Hydrogen	
Gas (m^3)	0.1
Helium	
Gas (m^3)	883
Liquid (L)	1,650

Source: KC ASI 1995a.

Waste Management. The solid and liquid nonhazardous wastes generated during modification activities would include concrete and steel construction waste materials and sanitary wastewater. The steel waste would be recycled as scrap material before completing construction. The remaining nonhazardous wastes generated during construction would be disposed of by the construction contractor. Sanitary wastewater would be processed in the sanitary wastewater system. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes generated during construction would consist of such materials as waste adhesives, oils, cleaning fluids, solvents, and coatings. Hazardous waste would be packaged in DOT-approved containers and shipped offsite to commercial RCRA-permitted treatment, storage, and disposal facilities. No radioactive waste would be generated during construction.

TABLE A.3.6.1–7.—*Kansas City Plant II Nonnuclear Fabrication Surge Operation Annual Emissions*

Pollutant	Quantity (t)
Acetone	0.32
Carbon monoxide	13.17
Chromium	<0.01
Cyanide	<0.01
Ethyl benzene	0.054
Formaldehyde	<0.01
Hydrochloric acid	0.018
Isopropyl alcohol	4.44
Methanol	0.009
Methyl ethyl ketone	0.14
Methyl isobutyl ketone	0.027
Particulate matter	1.03
Perc	0.29
Sulfur dioxide	0.35
Toluene	0.59
Toluene diisocyanate	<0.01
1,1,1-Trichloroethane	0.036
Trichloroethylene	3.82
Volatile organic compounds	13.05
Xylene	0.25

Source: KC ASI 1995a; KCP 1995a:3.

The project design considers and incorporates waste minimization and pollution prevention. To facilitate waste minimization, where possible, nonhazardous materials would be substituted for those materials that contribute to the generation of hazardous waste. Production processes would be configured with minimization of waste production given high priority. Material from the waste streams would be treated to facilitate disposal as nonhazardous wastes, where

TABLE A.3.6.1–8.—*Kansas City Plant II Nonnuclear Fabrication Facility Waste Volumes*

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations (m^3)	Annual Volume Effluent from Surge Operations (m^3)
Low-Level[a]			
Liquid	None	None	None
Solid	None	None	None
Mixed Low-Level[a]			
Liquid	None	None	None
Solid	None	None	None
Hazardous			
Liquid	None	60	60
Solid	786	61	61
Nonhazardous (Sanitary)			
Liquid	None	570,000	570,000
Solid	745	310	310
Nonhazardous (Other)			
Liquid	None	223,900	223,900
Solid	None	11,500	11,500

[a] LLW or mixed LLW would not be routinely generated during normal operations. However, upset conditions may result in the generation of minimal quantities of LLW or mixed LLW.

Source: KC ASI 1995a; KCP 1995a:2; KCP 1995a:3.

possible. Future D&D considerations have also been incorporated into the design.

Table A.3.6.1–8 presents the estimated annual waste volumes from the nonnuclear fabrication plant at Kansas City during construction and surge operations. Solid and liquid wastestreams are routed to the waste management system. Solid wastes would be characterized and segregated into hazardous or nonhazardous wastes, then treated to a form suitable for offsite disposal. Liquid wastes would be treated onsite to reduce hazardous/toxic elements before discharge or transport. All fire sprinkler water discharged in process areas is contained and treated as process wastewater, when required.

Transuranic Waste. The Nonnuclear Fabrication Facility at KCP would not generate any TRU waste.

Low-Level Waste. The Nonnuclear Fabrication Facility at KCP would not routinely generate any LLW.

Mixed Low-Level Waste. The Nonnuclear Fabrication Facility at KCP would not routinely generate any mixed LLW.

Hazardous Waste. Hazardous wastes generated by the Nonnuclear Fabrication Facility at KCP would consist of acidic and alkaline liquids, solvents, and oils and coolants. Processes such as plating, etching, electronic assembly, metals and plastics machining and forming, and wastewater treatment are the principal generators. Liquid hazardous wastes would be collected in DOT-approved containers and sent to an onsite hazardous waste accumulation area. The hazardous waste accumulation area would provide a 90-day staging capacity prior to shipment to an offsite commercial RCRA-permitted treatment, storage, and disposal facility, using DOT-certified transporters. After compaction, if appropriate, the solid hazardous wastes would be packaged in DOT-approved containers and sent to a hazardous waste accumulation area for staging, characterization, and packaging prior to shipment to an offsite commercial RCRA-permitted treatment, storage, and disposal facility using DOT-certified transporters.

Nonhazardous (Sanitary) Waste. Nonhazardous waste generated at the Nonnuclear Fabrication Facility at KCP primarily consists of liquid sanitary, nonrecyclable, nonhazardous solid sanitary, and industrial wastes. Liquid sanitary wastes would be collected by sewer pipe systems from most of the support buildings and discharged directly to the Kansas City municipal sanitary sewer system. Process wastewater is sent to holding tanks for treatment and recycled, where appropriate. Process rinsewater waste streams are routed to the industrial wastewater pretreatment facility for treatment and then discharged to the Kansas City municipal sanitary sewer system.

Nonhazardous (Other) Waste. One-pass cooling water, fire sprinkler water, water from air dryers and vacuum pumps, as well as stormwater from areas of KCP would be discharged through the Blue River and Indian Creek NPDES outfalls.

A.3.6.2 *Relocate to Los Alamos National Laboratory*

Historically, LANL has designed nuclear weapons and has fabricated the development hardware to support the nuclear weapon design process. LANL has made a clear distinction between fabrication for production and fabrication for design agency requirements. At LANL production agency responsibilities would be separately managed. The LANL alternative would rely primarily on in-house production of nonnuclear components and services. Table A.3.6–1 shows the list of nonnuclear products and make-buy decisions. The following sections describe the nonnuclear fabrication products and processes that would be carried out at LANL.

Plastics, Detonators, and Pilot Plant Operations. Technologies currently in place at LANL, with the exception of parylene coating, large scale polymer pilot operations, cellular silicone compounding, and certain filled polymer molding, can support production of all components under consideration.

Generic descriptions of the products or processes to be transferred include inert components for high energy main charge detonators, inert components for high energy neutron generator detonators, blown and cellular silicone foams, polyurethane foams, silicone elastomer molding, composite molding, commodity material molding, filled silicone molding, and pilot scale synthesis of polymeric materials.

Due to the small scale and specialty nature of weapons components, most would be made internally. Materials that would most likely be procured include commodity molded materials. Polyurethane resin currently fabricated at the polymer pilot plant is made in relatively large lots, and, as such, may be procurable from outside vendors. In all cases, internal capability would be maintained to fabricate all materials and components. If internal capability to fabricate specialty items were lost, the technical risk of meeting scheduled or unscheduled production deadlines would be significantly increased. Additional processing capability would be required in the areas of polyurethane foam dispensing, intensive mixing, extruding and leaching of cellular silicone, flame spraying, and parylene coating. For pilot plant operations, additional processing capability would be required for large scale processing of up to 380 L (100 gal). All detonator flat cable processing capability is currently available; however, upgraded equipment would be required to better meet production requirements. High energy detonator fabrication capabilities would need to be installed.

Reservoirs and Valves. LANL has the capability for small scale fabrication for valves and reservoirs in support of R&D of new boost systems, NTS operations, and local hydrodynamic or other experimental testing. Generic descriptions of the products or processes to be transferred include the procurement, certification, and storage of all nuclear-grade materials needed by production. These materials include different alloys of stainless steel, beryllium, copper, aluminum, weld filler materials, and other specialty materials unique to boost system applications. These materials may take the form of raw billets, forging, partially machined parts, finished machine parts, subassemblies, and finished assemblies. Also included in this parts list are vendor purchased parts such as elastomer seals, metal seals, screws, and filters. Fabrication of boost systems includes the procurement of material stock, machining operations, mechanical and radiographic inspection, cleaning, welding, assembly, proof pressure testing, leak testing, volume measurement, packaging, storage, and shipment. As part of the

product certification, shelf life storage units would be manufactured to represent the product and monitored throughout the stockpile life.

Facility Description. LANL occupies an area of 111,000 ha (274,000 acres) with 30 active TAs (figure A.3.6.2–1). Figures A.3.6.2–2 through A.3.6.2–5 show the detailed facility layout for project TAs.

The following facilities, with the specified installations/upgrades, would be used for nonnuclear production activities at LANL:

- *Plastics production.* TAs-16-302, -303, -304, -305, -306, and -307: New or transferred equipment would be installed in these facilities. Electrical system upgrades would be required in some of these facilities.

- *Reservoir and valve production.* TA-3-SM-39: Removal of existing machine tools and replacement with new or transferred machine tools would be required. No other upgrades would be necessary.

- *Detonator component manufacture.* TA-22-91: New or transferred equipment would be installed at this facility. Electrical systems upgrades would be required.

- *Large scale pilot plant polymer synthesis.* TA-16-340: New or transferred equipment would be installed at this facility. Electrical systems upgrades would be required.

- *Small scale pilot plant polymer synthesis operations.* TA-35-213; no additional installations or upgrades required.

- *Mold storage.* TA-16-332: no installations or upgrades required.

Table A.3.6.2–1 presents facility data for the nonnuclear fabrication missions at LANL.

Technical Areas-16-302, -303, -304, -305, -306, and -307. These buildings would contain the plastics production activities associated with the proposed production activities. Buildings 302, 304, and 306 are single story with equipment room basements. Buildings 303, 305, and 307 are single story. Th buildings are each concrete-walled, roofed stru tures that currently house plastics-related produ tion, fabrication, and storage functions. Each of th buildings is served by 480-volt power and each h existing process steam, vacuum, air, and ventilatic systems required for plastics fabrication and manu facture. The proposed production activities woul require that several types of new or transferre equipment (mixers, extruders, roll mills, presse coaters, screeners, testing equipment, and qualit assurance equipment) be installed in Buildings 30 through 307. Building 302 would be used for raw material storage and bonded material/product storage. Although the existing electrical power would accommodate the added equipment, power distribution panels and associated wiring would have to be upgraded in some facilities. The steam, ventilation, air, and vacuum systems would not require upgrades.

Technical Area-3-SM-39. This facility would contain the metal machining, inspection, packaging, and storage functions required for reservoir and valve production. The facility is a two-story (second floor is mezzanine), concrete-walled, roofed structure with steel beam construction. The facility was originally designed as and is currently used as a machine shop, with air ventilation systems required for metal machining. The proposed production activities would require that several types of new or transferred machine tools (lathes, mills, drills, grinders, welders, inspection/testing equipment) be installed. Although the existing electrical power would accommodate the added equipment, power distribution panels and associated wiring would have to be installed for the specific machines. Besides rearranging equipment and storage locations, no other upgrades would be required.

Technical Area-22-91. This facility would contain the inert detonator manufacture and assembly operations. The facility is a single-story, block and concrete structure with joist/concrete roof that was originally designed for detonator fabrication and assembly. The proposed production activities would require that several types of new or transferred equipment be installed. Although the existing electrical power would accommodate the added equipment, power distribution panels and associated wiring would have to be installed for the specific equipment. No other upgrades would be required.

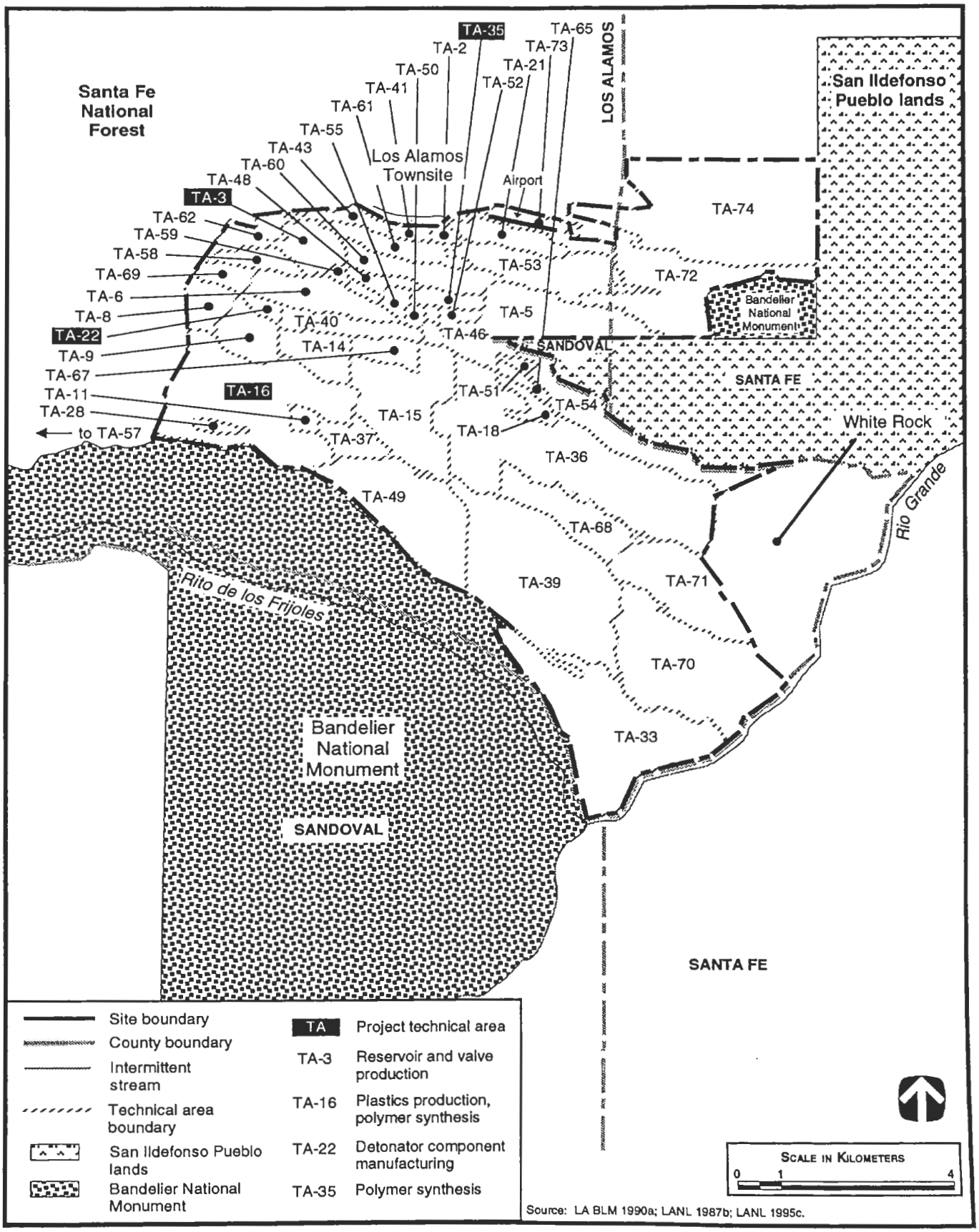


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FIGURE A.3.6.2–1.—*Nonnuclear Fabrication Alternative Technical Areas at Los Alamos National Laboratory.*

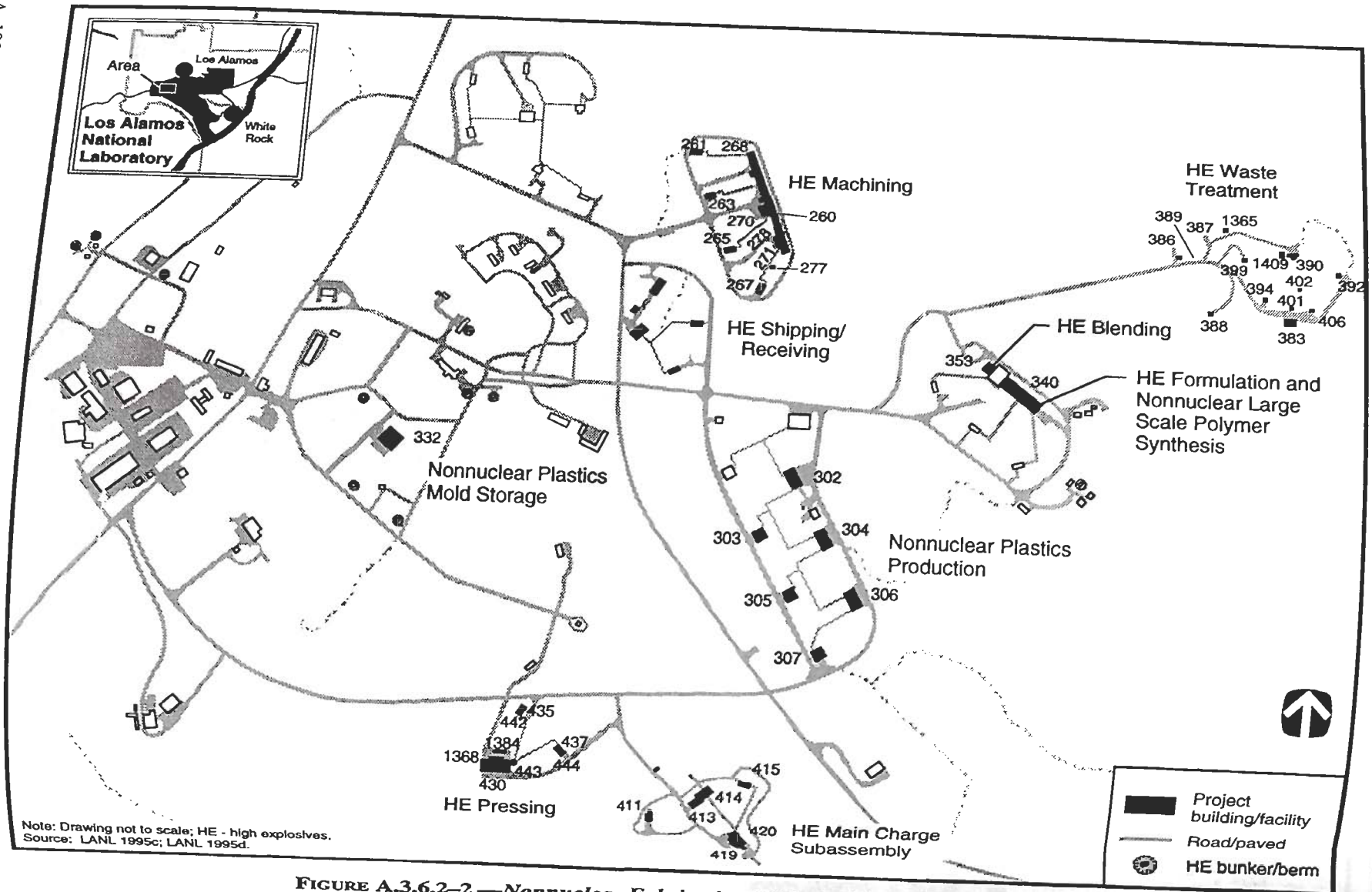


FIGURE A.3.6.2–2.—*Nonnuclear Fabrication Technical Area 16 Site Plan at Los Alamos National Laboratory.*

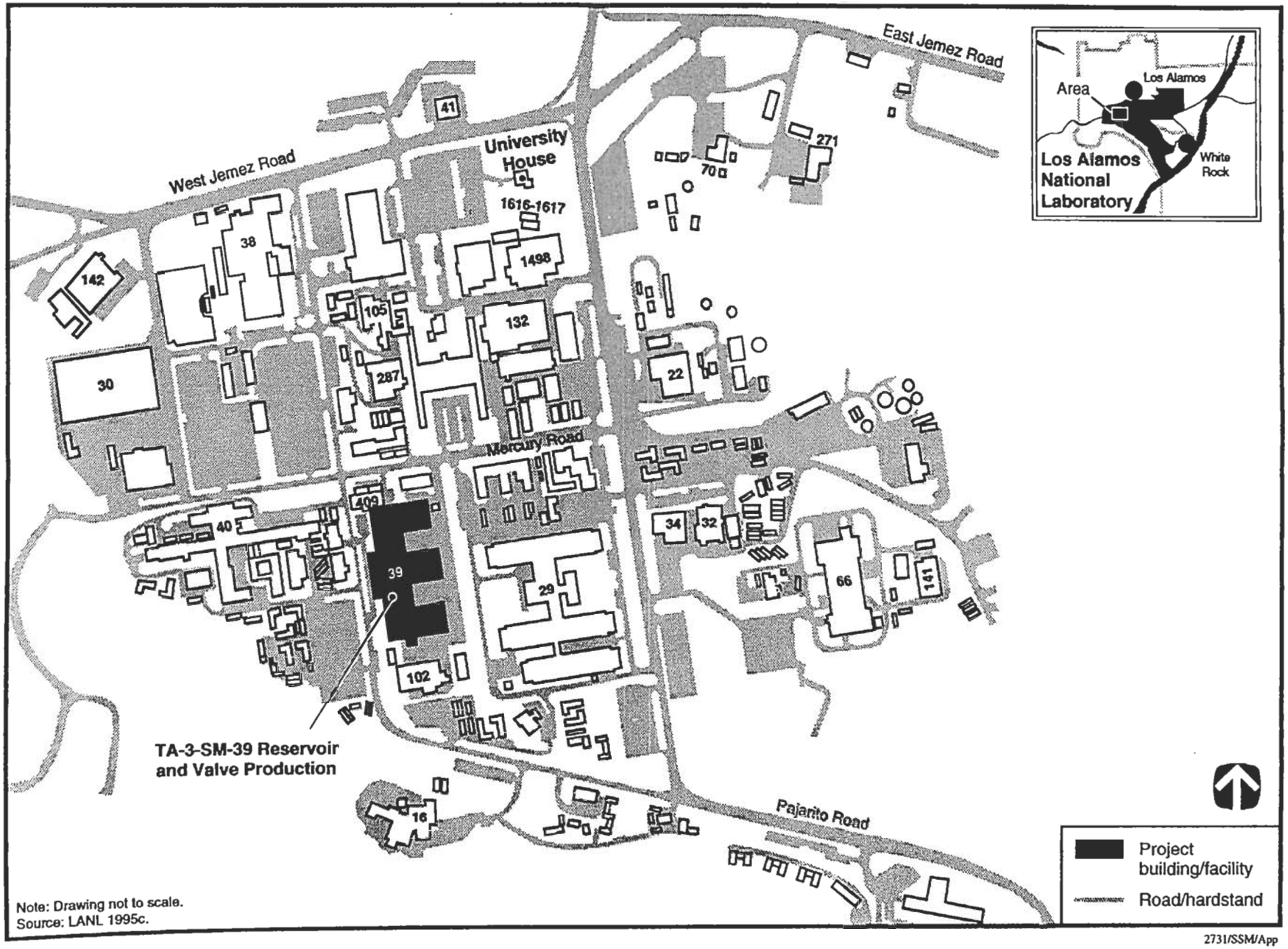


FIGURE A.3.6.2–3.— ***Nonnuclear Fabrication Technical Area 3-SM-39 Site Plan at Los Alamos National Laboratory.***

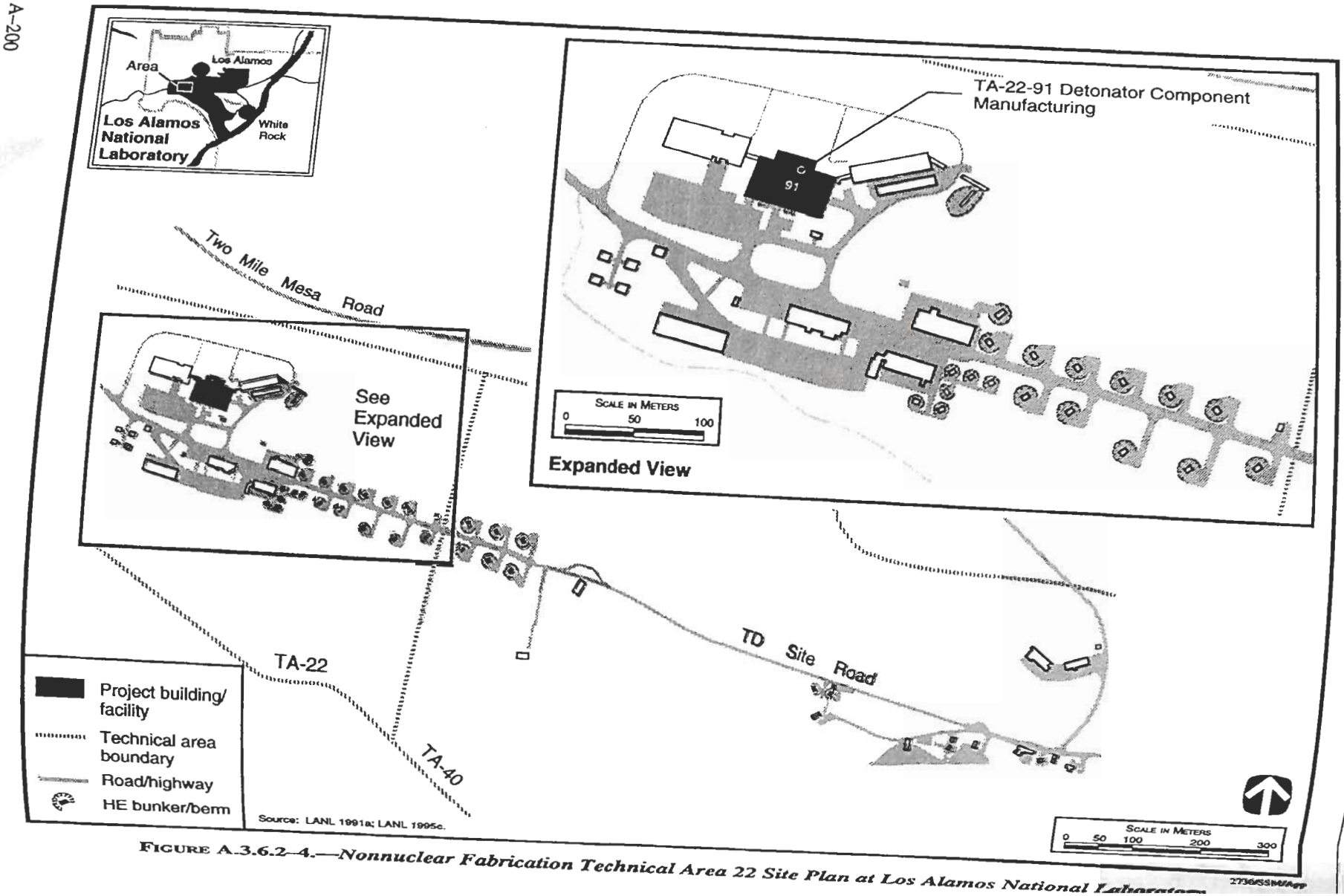


FIGURE A.3.6.2-4.—*Nonnuclear Fabrication Technical Area 22 Site Plan at Los Alamos National Laboratory*

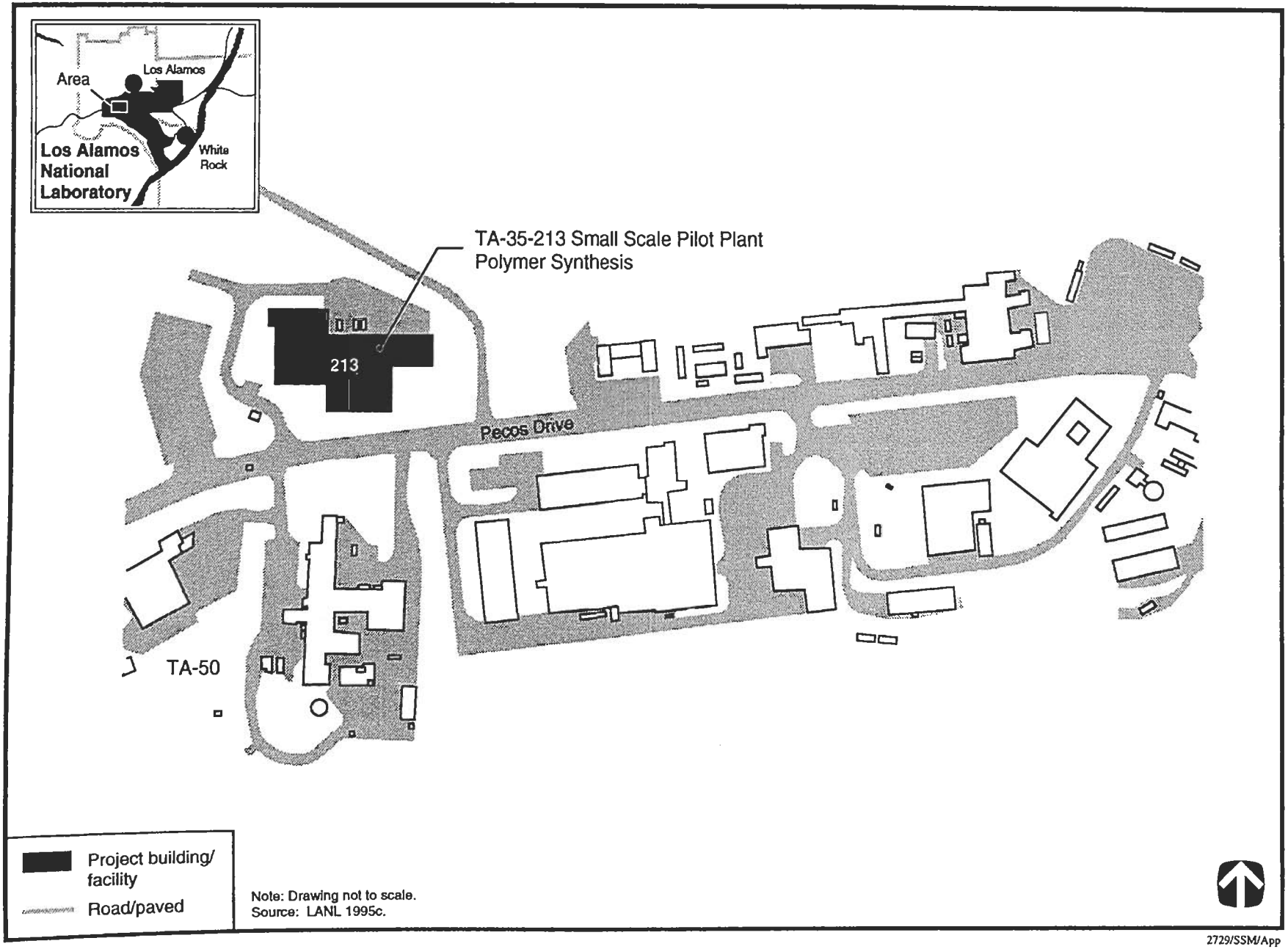


FIGURE A.3.6.2–5.—*Nonnuclear Fabrication Technical Area 35 Site Plan at Los Alamos National Laboratory.*

TABLE A.3.6.2–1.—*Los Alamos National Laboratory Nonnuclear Facilities*

Facility	Number of Stories	Total Space (m^2)	Utilized Space[a] (m^2)	Construction Type
TA-3-SM-39	2	10,405[b]	2,323	Concrete with steel beam
TA-16-302	1	566	566	Concrete walls/roof
TA-16-304	1	566	566	Concrete walls/roof
TA-16-306	1	566	566	Concrete walls/roof
TA-16-303	1	273	273	Concrete walls/roof
TA-16-305	1	273	273	Concrete walls/roof
TA-16-307	1	273	273	Concrete walls/roof
TA-16-332	1	929	929	Steel joist/metal sheet
TA-16-340	2	2,111[b]	149	Concrete walls/roof
TA-22-91	1	2,002	2,002	Concrete walls/roof
TA-35-213	3	7,880	1,125	Concrete walls/roof

[a] Space in existing facility that will be used for the proposed production activity.

[b] Includes mezzanines.

Source: LANL 1995c.

Technical Area-16-340. Bays 109 and 110 of this facility would contain the large scale pilot plant polymer synthesis. The building is a two-story (second floor is equipment room) concrete-walled, roofed structure with blowout walls originally designed for explosive synthesis operations. The proposed production activities would require that a reactor vessel, mixer heater, pulverizer, solvent recovery equipment, and storage area be located in the bays. New electrical service to the equipment would have to be installed. No other upgrades would be required.

Technical Area-35-213. This facility would contain the small scale plant polymer synthesis. The building is a three-story formed concrete structure with a joist/concrete roof. The proposed production activities would not require any modification or installations as all of the required equipment currently exists.

Technical Area-16-332. This facility would be used as a storage area for raw materials and/or components associated with the proposed production activities. The building is a single-story, steel-framed metal building. No upgrades or installations would be required.

Table A.3.6.2–2 presents a schedule for implementation of nonnuclear fabrication activities at LANL. Construction would consist of new or transferred equipment in existing facilities and upgrades to electrical systems within the proposed facilities. The proposed installations and modifications would occur over a 2-year period. The resources and raw materials would consist of only what would be required to install 50 pieces of equipment and to upgrade electrical systems. Materials/resources consumed during the entire construction phase are presented in table A.3.6.2–3.

TABLE A.3.6.2–2.—*Los Alamos National Laboratory Schedule of Activities for Nonnuclear Fabrication*

Activity	Start	End
Research and development duration	1/96	1/97
Hazard/risk assessment, NEPA determination	1/96	1/98
Engineering design (conceptual, final)	1/97	1/00
Modifications/equipment installations	1/00	1/01
Mission transfer/qualification/ proof of operation	1/99	12/02
Steady-state operations	12/02	
Decontamination/decommissioning or conversion	1/30	

Source: LANL 1995c.

Because the construction activities associated with the proposed activities would consist only of installa-

TABLE A.3.6,2–3.—*Los Alamos National Laboratory Nonnuclear Fabrication Construction/Upgrade Materials/Resources Requirements*

Material/Resource	Total Consumption	Peak Demand
Electricity	105 kWh	3.8kWe
Electrical wiring (m)	762	
Conduit (m)	3,050	
Water (L)	9,500	

Source: LANL 1995c.

tion of equipment and upgrade of electrical systems, there would be no aerial emissions of criteria or other pollutants.

Only small quantities of nonhazardous solid and liquid wastes would be generated as a result of the equipment installation and electrical upgrade work required for the proposed activities. Table A.3.6.2–4 lists the total number of personnel that would be required to perform the installation/modification work. This includes only those actually involved with the work and does not include process development or design work. The number of employees listed are spread out over a 1-year period, and more than the listed quantity could be present at any time during the year (1.5 workers per year may consist of 3 workers for a 6-month period).

TABLE A.3.6.2–4.—*Los Alamos National Laboratory Nonnuclear Fabrication Construction Workers*

Employees	2000	2001	Total
Total craftworkers	3.0	3.0	6
Construction (installation) management/support staff	0.25	0.25	0.5
Technical support personnel	2.0	2.0	4
Project support personnel	1.0	1.0	2
Total Employment	6.25	6.25	12.5

Source: LANL 1995c.

Table A.3.6.2–5 provides estimates of the electrical, steam, and water usage that would be added to facility surge operations due to the proposed action. Because all of the activities would occur in existing buildings, space heating loads and electrical loads from normal occupancy (lighting and ventilation) are not included. Raw water consumption includes added sanitary usage from increased personnel that would occupy the facilities due to the proposed activities.

It is noted that all of the facilities associated with the proposed activities are heated either by steam or by central gas heating systems. At the TA-16 facilities, steam is also used as a process heating method and for process washdown/cleaning activities.

TABLE A.3.6.2–5.—*Los Alamos National Laboratory Nonnuclear Fabrication Surge Operation Annual Utility Requirements*

Utility	Consumption	Peak Demand[a]
Electricity	525 MWh	0.23 MWe
Liquid fuel	None	
Natural gas	340	
Steam (m^3)	95	
Raw water (L)	48,300,000	

[a] Peak demand is the maximum rate expected at any hour.
Source: LANL 1995b:3; LANL 1995c.

Table A.3.6.2–6 lists the annual chemicals consumed during surge operation.

TABLE A.3.6.2–6.—*Los Alamos National Laboratory Nonnuclear Fabrication Surge Operation Annual Chemical Requirements*

Chemical	Quantity
Raw materials/chemicals used for plastics formulation	38,600
Metals for valve/reservoir/detonator production (kg)	3,020
Machine tool cutting fluids/lube oils (kg)	511
Cleaning/developing fluids for detonator assembly (kg)	2,270

Source: LANL 1995c.

Emissions. None of the proposed activities would require discharge to existing NPDES-permitted outfalls. Although there would be a slight increase in once-through cooling water discharged from the steam plant to an NPDES outfall resulting from the slight increase in process steam usage, this is not con-

sidered to be a pollutant. Aerial emissions of combustion by-products from the slight increase in process steam usage are listed as annual surge operation emissions in table A.3.6.2–7.

TABLE A.3.6.2–7.—*Los Alamos National Laboratory Nonnuclear Fabrication Surge Operation Annual Emissions*

Pollutant	Quantity (t)
Carbon monoxide	0.0002
Nitrogen oxides	0.0002
Particulate matter	0.00007
Sulfur oxides	0.000003
Volatile organic compounds	0.282

Source: LANL 1995c.

Waste Management. Small amounts of nonhazardous liquid and solid wastes would be generated as a result of the installation of equipment and upgrade of the electrical systems. No radioactive waste or hazardous waste would be generated during construction.

The project design considers and incorporates waste minimization and pollution prevention. Production processes would be configured with minimization waste production given high priority. Material fr the waste streams would be treated to facilit disposal as nonhazardous wastes, where possib Future D&D considerations have also been incorp rated into the design.

Table A.3.6.2–8 presents the estimated annual wa volumes from the Nonnuclear Fabrication Facility LANL during modification activities and surge op ations. Solid and liquid waste streams are routed the waste management system. Solid wastes wou be characterized and segregated into hazardous a nonhazardous wastes, then treated to a form suitab for offsite disposal or storage within the facilit Liquid wastes would be treated onsite to reduce ha ardous/toxic characteristics before discharge c transport.

Transuranic Waste. The Nonnuclear Fabricatic Facility at LANL would not generate any TRU wast

Low-Level Waste. The Nonnuclear Fabricatic Facility at LANL would not generate any LLW.

Mixed Low-Level Waste. The Nonnuclear Fabricatic Facility at LANL would not generate any mixed LLW.

TABLE A.3.6.2–8.—*Los Alamos National Laboratory Nonnuclear Fabrication Waste Volumes*

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations[a] (m^3)	Annual Volume Effluent from Surge Operations (m^3)
Hazardous			
Liquid	None	11	11
Solid	None	0.11	0.11
Nonhazardous (Sanitary)			
Liquid	None	568	566[b]
Solid	None	10	6[c]
Nonhazardous (Other)			
Liquid	5[d]	25[e]	None
Solid	0.04	3[f]	None

[a] Data for multiple shift were not provided. Single-shift values were multiplied by 3.
[b] Assumes a 350:1 wastewater to sludge ratio in the treatment of liquid sanitary wastes.
[c] Assumes that 2/3 of the solid waste is compactible by a factor of 4:1.
[d] 2,500 gal of cleanup/washdown water, converted to cubic meters and divided by 2 for the 2-year construction period.
[e] Industrial liquid wastes which include cleaners, cutting liquids, lube oils, and developers are recycled.
[f] Metal machining wastes, wire, scrap, and molds are recycled.
Source: LANL 1995c.

Hazardous Waste. Some hazardous wastes would be generated as a result of the Nonnuclear Fabrication Facility at LANL; however, no new hazardous waste streams would be generated. These wastes consist of liquid solvent wastes and solid beryllium wastes from machining operations. Liquid hazardous wastes would be collected in DOT-approved containers and sent to an onsite hazardous waste accumulation area. The hazardous waste accumulation area would provide a 90-day staging capacity prior to shipment to an offsite commercial RCRA-permitted treatment, storage, and disposal facility, using DOT-certified transporters. The solid hazardous wastes would be packaged in DOT-approved containers and sent to a hazardous waste accumulation area for staging, characterization, and packaging prior to shipment to an offsite commercial RCRA-permitted treatment, storage, and disposal facility using DOT-certified transporters.

Nonhazardous (Sanitary) Waste. Nonhazardous process wastes generated at the Nonnuclear Fabrication Facility at LANL consist of washdown and cleaning water containing soaps and other cleaning agents. These wastes would be discharged to the sanitary waste systems. Solid nonhazardous plastics waste and wastewater sewage sludge is disposed of in offsite industrial and sanitary landfills.

Nonhazardous (Other) Waste. Liquid nonhazardous wastes such as spent machine tool cutting fluids and spent lubricating oils will either be recycled or disposed of onsite or offsite by the LANL Waste Management Group. Solid nonhazardous wastes such as excess electrical wire, resins, and molds would also be generated. This waste would be salvaged, recycled, or disposed of offsite.

A.3.6.3 *Relocate to Lawrence Livermore National Laboratory*

Nonnuclear fabrication at LLNL would include production or procurement of all plastic components, polymers, and composite parts. Nearly all processes are currently, or have been, in operation at LLNL on the same scale as needed for the nonnuclear fabrication mission. The nonnuclear fabrication mission would be accomplished within 15 departments listed in table A.3.6.3–1.

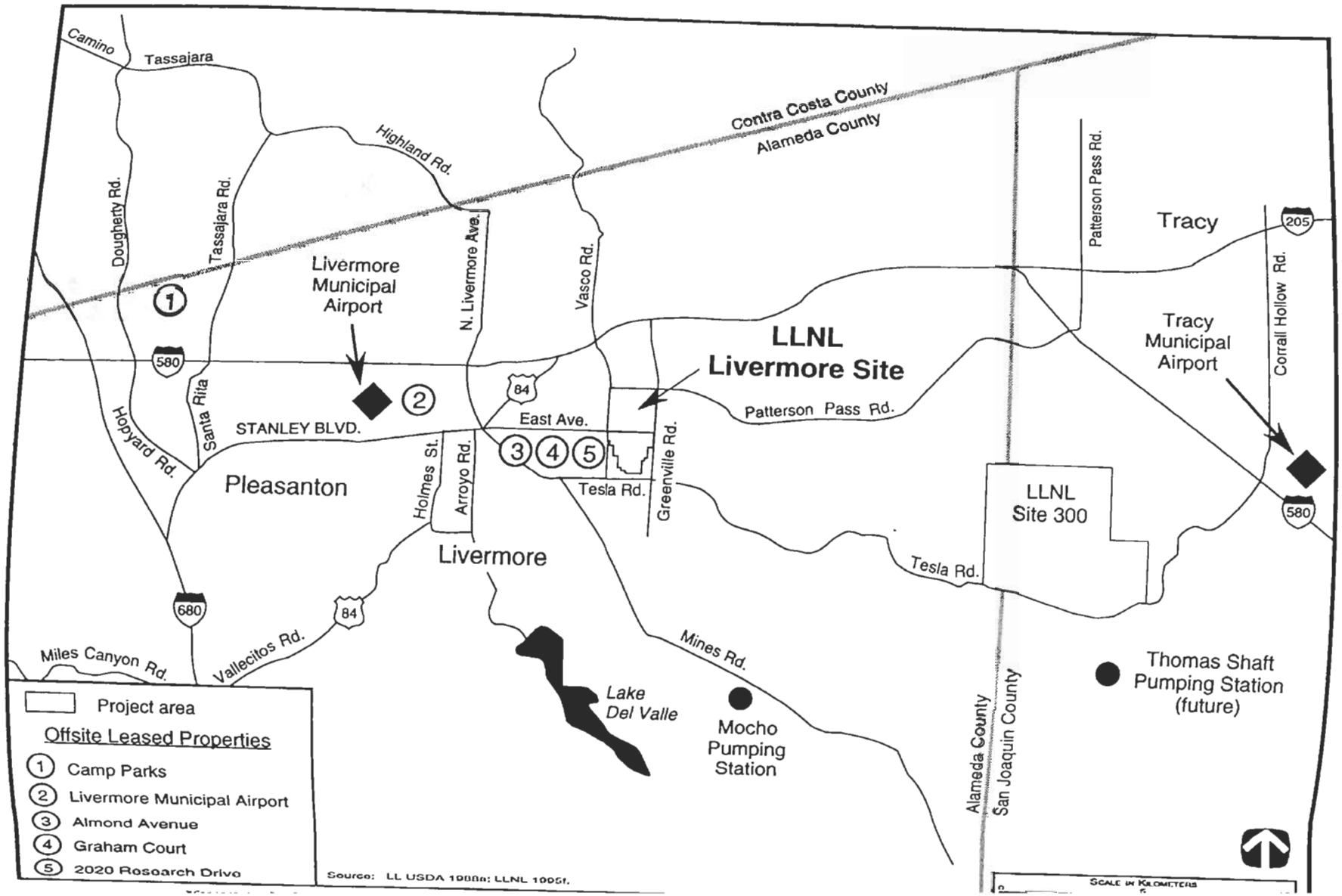
TABLE A.3.6.3–1.—*Lawrence Livermore National Laboratory Existing Nonnuclear Fabrication Departments*

Department Number	Function
1	Compression molding
2	Transfer molding
3A	Cellular silicone foam
3B	Brown silicone foam
4	Injection molding
5	Polyurethane foam molding
6	Casting and encapsulation
7	Machining
8	Composite fabrication
9	Repackaging
10	Polymer synthesis
11	Receiving
12	Packaging/shipping
13	Document control
14	Quality control
15	In-process material handling

Source: LLNL 1995f.

Nonnuclear fabrication would take place at the Livermore Site as shown in figure A.3.6.3–1. The fabrication, including polymer synthesis, would be confined to a consolidated area consisting of five adjacent buildings as shown in figure A.3.6.3–2.

Departments 1, 2, 3B, 4, 6, 7, 8, and 9 currently exist in dedicated facilities within the B231 complex at LLNL. Equipment for Department 5 is available but would be relocated to B131 in an existing low-relative-humidity operations area. Relative-humidity-sensitive and precision machining operations would also be located in this area. Department 3A would most likely be a scaled down version of the existing process and would be located in area B231. Department 10 would be an entirely new process which would be located in B232. Large scale storage of incoming and finished product would be accomplished in B131 adjacent to the Department 5 facility. Receiving inspections would be accomplished in B223. Finished product packaging and short-term storage would be in B227. In-process storage would be in the high bay area on B231. Support offices and in-process quality control would also be located in B231.


Camino
Tassajara
Contra Costa County
Alameda County
Highland Rd.
Dougherty Rd.
Tassajara Rd.
Livermore Municipal Airport
N. Livermore Ave.
Vasco Rd.
Patterson Pass Rd.
Tracy
205
LLNL Livermore Site
Tracy Municipal Airport
Corrall Hollow Rd.
580
84
Santa Rita
Hopyard Rd.
STANLEY BLVD.
East Ave.
Patterson Pass Rd.
Pleasanton
Holmes St.
Arroyo Rd.
Tesla Rd.
Greenville Rd.
LLNL Site 300
Livermore
680
Vallecitos Rd.
Miles Canyon Rd.
Mines Rd.
Lake Del Valle
Mocho Pumping Station
Thomas Shaft Pumping Station (future)
Alameda County
San Joaquin County
Project area
Offsite Leased Properties
1 Camp Parks
2 Livermore Municipal Airport
3 Almond Avenue
4 Graham Court
5 2020 Research Drive
Source: LL USDA 1988a; LLNL 1995f.
Scale in Kilometers

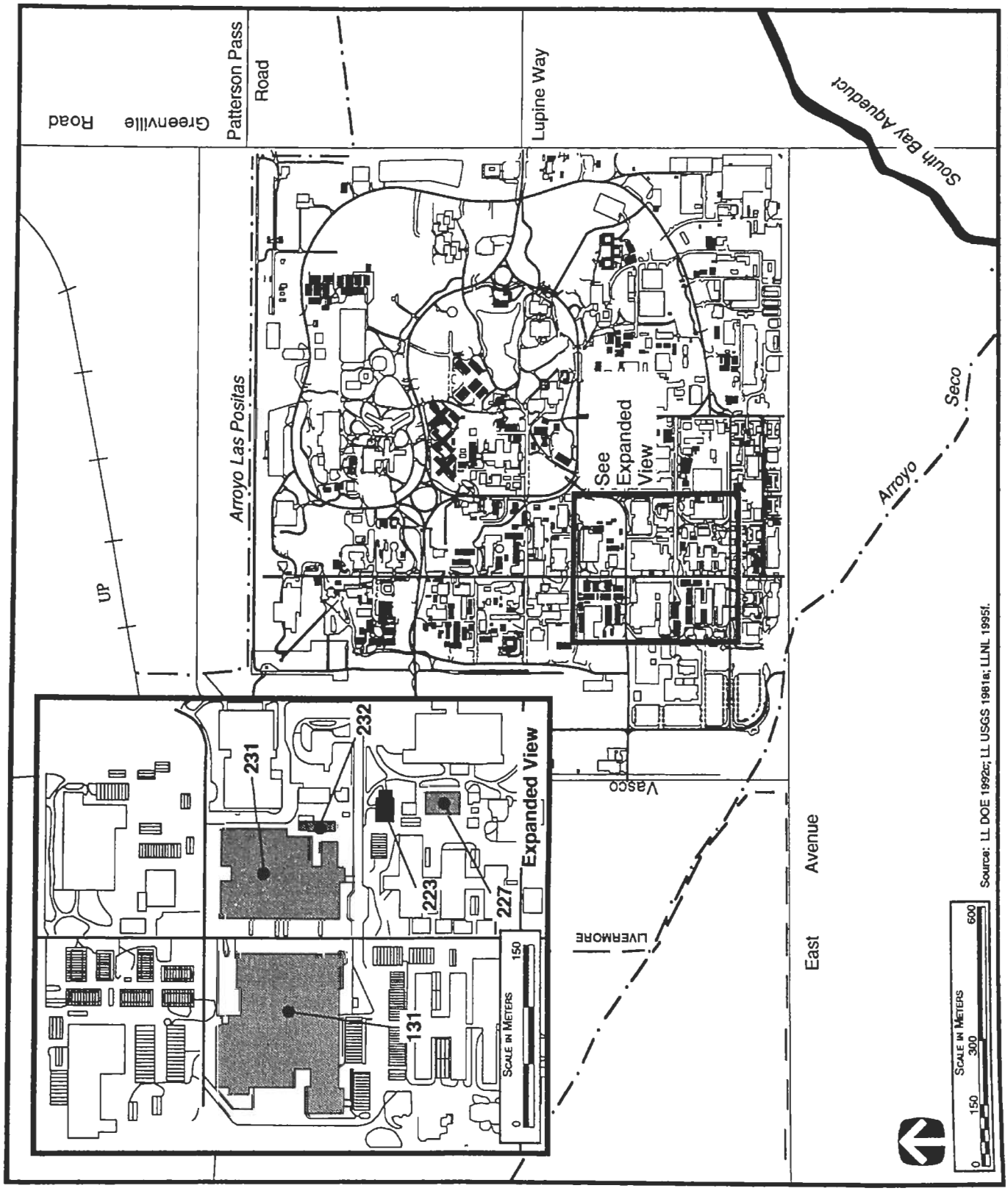


FIGURE A.3.6.3–2.—*Nonnuclear Production Facility Plot Plan at the Livermore Site.*

The process/products included in the LLNL nonnuclear fabrication alternative are transfer molded parts, compression molded parts, injection molded parts, machined plastic parts, silicone cushion (all types), syntactic components, filled polymers, and polymer synthesis.

This alternative covers processes for fabrication of nearly all plastic nonnuclear components needed to meet nonnuclear fabrication requirements. There are a few components that can be obtained more cost effectively through procurement. Some very specialized plastic film and tubing parts for certain assemblies may more effectively be produced or procured by the agency producing the assembly. Synthesis of basic polymers is included to provide raw materials that are not commercially available.

Compression Molding. The compression molding process would be used to produce filled and unfilled, elastomeric or rigid, thermosetting components.

Existing roll mill capacity would be sufficient for all products except cellular silicone. Currently ceramic rolls are used for high purity instead of beryllium oxide rolls utilized at KCP. The beryllium oxide rolls would have to be transferred or a modification made to the process specifications to allow for other materials. An intermediate size roll mill and Banbury mixer for use with cellular silicone are included in capital equipment. Scales, preform cutting, and in-process storage are available.

The facility is capable of utilizing integrally heated or platen heated tools. Thus, existing tooling should be sufficient in all cases. Tooling would be stored in the B231 complex in the 1300 Wing.

There is very little transfer molding involved in this alternative. Diallyl phthalate electronic components would be procured by the agency needing the components. However, the capability would exist within the production facility.

Preforming would be done on existing compression or transfer presses located in Department 2. The dielectric heater would be transferred from the production agency or purchased new. Post cure can be accomplished in the current oven capacity at the facility. In-process trim and inspection would be accomplished in the same area used for compression molded parts. Overflow inspection capability w exist in room 1240.

Cellular Silicone Compounding. The current duction process for cellular silicone compound could either be scaled down to a more appropr size or the equipment could be transferred from current production agency. The most economi approach would be to scale this process down much smaller batch size. Similar parts were made years ago in the existing equipment at LLNL. T equipment includes the Banbury mixer, compou ing roll mills, and sheeting roll mills. Producti levels dictate an equipment size in-between those LLNL and KCP. The current proposal allows scaling down the process; however, there is an a set aside in the B231 high bay for installation of K equipment. Another option would be to transfer t production agency equipment to LLNL. In that cas the compounding operations would be installed in t high bay of B231 in place of existing temporar structures.

The urea screening operation either would be tran ferred from the production agency or a new system smaller capacity would be installed at LLNL. Th equipment would be scheduled for B231, in a dedicated area in either case. Washing and drying operations would be located in B231 in a newly enclosed area in Wing 1200. Two washers would b transferred from KCP. A reverse osmosis wate system would be installed in B232 and piped to the 1200 Wing of B231. A new drying oven would be purchased. Molding operations would be conducted in the compression molding department.

Blown Silicone Foam Molding. The current operation for blown silicone foam molding in department 3B utilizes equipment in the compression molding department. There is some ancillary equipment in place that is functionally identical to that used at KCP.

Injection Molding. The installed injection molding (Department 4) capacity at LLNL includes machines of up to 260-g (9-ounce) and 100-t (110-ton) capacity. The capability at KCP includes machines of this size and also 400, 740, 790, and 2,270 g (14, 26, 28, and 80 ounces). The need for this larger equipment would be evaluated as the requirement warranted. The machines at LLNL are in excellent condition. The

100-t (110-ton) machine at LLNL utilizes dedicated computer control. This feature is very useful in a production environment when a variety of products are involved because of the rapid, error free setting of machine variables from stored programs. Large polymethylpentene blanks are currently made at KCP using the 2,270-g (80-ounce) injection molding machine in a specialized process that is somewhat similar to compression injection but on a very large scale. This process could be sent to an outside vendor if a change in grade of material could be approved. This would be the option of choice. However, there are two other options: install the 2,270-g (80-ounce) machine in the B231 high bay adjacent to existing injection molding facilities or qualify the process currently in use at LLNL for the production of large polymethylpentene castings.

Polyurethane Foam Molding. LLNL currently operates three machines in Department 5 that can be utilized for the polyurethane foam molding process. One is a resin transfer molding unit that can be modified for foam. This machine is extremely versatile and would be the machine of choice for most production.

This process would be located in Wings 1300 and 1400 of B131, less than 100 m (328 ft) from the Central Process Area in B231. This is the location of preference since 10 percent relative humidity control is installed and operational. Foam and other relative humidity sensitive and precision machining operations would be collocated in the same wing. Much of that machining capacity is already installed. Existing tooling could be used in all cases. Tooling storage would be in an adjacent storage area.

Casting and encapsulation. Casting and encapsulation is a routine operation in the current Department 6 facility, and no significant changes are anticipated. Vacuum/pressure encapsulators are available. Existing tooling should be adequate in all cases. Tooling storage would be similar to that for compression molding.

Machining. Machining operations would be conducted in Department 7 in the B231 Machine Facility in Wing 1500. Composite machining would occur in Room 1019, B231. This room is currently dedicated to this type of machining and has the proper tooling, including diamond tools, and the proper high speed machining heads. HEPA filtration and high velocity dust extraction is built into this facility.

Low relative humidity and precision machining would occur in B131. The current facility can be humidity controlled to less than 10 percent relative humidity and has substantial matching and inspection capability in place. Certain specific machines may have to be relocated from other onsite locations or, if necessary, from KCP.

Composite Fabrication. There is only a small amount of composite fabrication needed for this alternative. These few parts can readily be fabricated in the current facilities, located in Department 8. The most sophisticated component is a carbon/phenolic part. The existing 318-t (350-ton) press has highly flexible bump cycle programming which can be utilized for fabricating this part.

Repackaging. Repackaging is a routine operation within the existing Department 9 facility. No additional changes would be required for this alternative.

Polymer synthesis. Polymer synthesis would be a new Department 10 operation at LLNL. Reactors of 190- and 380-L (50- and 100-gal) capacity and associated support equipment would be located in B232. Reactors, complete with a dedicated hot oil heating system, are included in capital equipment. The units would be installed in the south portion of B232. This is an abandoned high pressure facility and is ideal for this operation. Items such as product dryers and precipitators would be transferred from KCP.

A list of materials and resources consumed during modification activities can be found in table A.3.6.3–2. A list of emissions produced during modification activities can be found in table A.3.6.3–3. A list of construction workers needed during the modification phase can be found in table A.3.6.3–4. A list of utilities consumed during surge operation can be found in table A.3.6.3–5. A list of the annual chemicals consumed during surge operation can be found in table A.3.6.3–6. A list of emissions produced during surge operations can be found in table A.3.6.3–7.

Waste Management. The solid and liquid nonhazardous wastes generated during modification activities would include concrete and steel construction

TABLE A.3.6.3–2.—*Lawrence Livermore National Laboratory Nonnuclear Fabrication Construction/Modification Materials/Resources Requirements*

Material/Resource	Total Consumption	Peak Demand[a]
Electricity	21 MWh	50 kWe
Fuel (L)	19,900	
Water (L)	79,500	
Concrete (m^3)	7.6	
Steel (t)	7.3	
Industrial gases (m^3)	7.5	

[a] Peak demand is the maximum expected during any hour.
Source: LLNL 1995f.

TABLE A.3.6.3–3.—*Lawrence Livermore National Laboratory Nonnuclear Fabrication Construction/Modification Emissions*

Pollutant	Quantity (t/yr)
Carbon monoxide	3.08
Nitrogen oxides	1.09
Particulate matter	0.36
Sulfur dioxide	0.09
Volatile organic compounds	0.54

Source: LLNL 1995f.

TABLE A.3.6.3–4.—*Lawrence Livermore National Laboratory Nonnuclear Fabrication Construction/Modification Construction Workers*

Employees	Year 1	Year 2	Year 3	Year 4	Year 5	Total
Architectural design	0.14	0.35	0.43	0.35	0.14	1.4
Plant design	0.09	0.22	0.26	0.22	0.09	0.9
Project manager	0.09	0.22	0.26	0.22	0.09	0.9
Construction manager	0.13	0.31	0.38	0.31	0.13	1.3
Inspectors	0.13	0.31	0.38	0.31	0.13	1.3
Document clerk	0.01	0.03	0.04	0.03	0.01	0.1
Craftworkers	1.27	3.20	3.80	3.20	1.27	12.7
Total Employment	1.9	4.6	5.5	4.6	1.9	18.6

Source: LLNL 1995f; LLNL 1995i:2.

TABLE A.3.6.3–5.—*Lawrence Livermore National Laboratory Nonnuclear Fabrication Surge Operation Annual Utility Requirements*

Utility	Consumption	Peak Demand
Electricity	108 MWh	0.095 MW
Natural gases (m^3)	28,900	
Liquid fuel (L)	0	
Water (L)	3,790,000	

[a] Peak demand is the maximum rates expected at any hour.
Source: LLNL 1995f; LLNL 1995i:2

TABLE A.3.6.3–6.—*Lawrence Livermore National Laboratory Nonnuclear Fabrication Surge Operation Annual Chemical Requirements*

Chemical	Quantity
Nitrogen	
Gas (m^3)	37.8
Liquid (L)	278,000
Argon	
Gas (m^3)	39.2
Liquid (L)	3,420
Carbon dioxide	
Gas (m^3)	2.35
Liquid (L)	1,760
Hydrogen	
Gas (m^3)	0.04
Liquid (L)	0
Helium	
Gas (m^3)	71.64
Liquid (L)	22.7

Source: LLNL 1995f; LLNL 1995i:2.

TABLE A.3.6.3–7.—*Lawrence Livermore National Laboratory Nonnuclear Fabrication Surge Operation Annual Emissions*

Chemical	Quantity (t)
Acetone	0.066
Isopropanol	0.13
Methyl ethyl ketone	0.006
Toluene	0.006

Source: LLNL 1995f.

waste materials and sanitary wastewater. The steel waste would be recycled as scrap material before completing construction. The remaining nonhazardous wastes generated during construction would be disposed of by the construction contractor. Uncontaminated wastewater would be used for soil compaction and dust control, and excavated soil would be used for grading and site preparation. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling.

Hazardous wastes generated during construction would consist of such materials as waste adhesives, oils, cleaning fluids, solvents, and coatings. Hazardous waste would be packaged in DOT-approved containers and shipped off site to commercial RCRA-permitted treatment, storage, and disposal facilities. No radioactive waste would be generated during construction.

The project design considers and incorporates waste minimization and pollution prevention. Segregation of activities that generate radioactive and hazardous wastes would be employed, where possible, to avoid the generation of mixed wastes. Where applicable, treatment to separate radioactive and nonradioactive components would be performed to reduce the volume of mixed wastes and provide for cost-effective disposal or recycle. To facilitate waste minimization, where possible, nonhazardous materials would be substituted for those materials which contribute to the generation of hazardous or mixed waste. Production processes would be configured with minimization of waste production given high priority. Material from the waste streams would be treated to facilitate disposal as nonhazardous wastes, where possible. Future D&D considerations have also been incorporated into the design.

Table A.3.6.3–8 presents the estimated annual waste volumes from the Nonnuclear Fabrication Facility at LLNL during modification activities and surge operations. Solid and liquid waste streams are routed to the waste management system. Solid wastes would be characterized and segregated into nonhazardous or hazardous wastes, then treated to a form suitable for disposal or storage within the facility. Liquid wastes would be treated onsite to reduce hazardous/toxic elements before discharge or transport. All fire sprinkler water discharged in process areas is contained and treated as process wastewater, when required.

Transuranic Waste. The Nonnuclear Fabrication Facility at LLNL would not generate any TRU waste.

Low-Level Waste. The Nonnuclear Fabrication Facility at LLNL would not generate any LLW.

Mixed Low-Level Waste. The Nonnuclear Fabrication Facility at LLNL would not generate any mixed LLW.

Hazardous Waste. Hazardous wastes generated by the Nonnuclear Fabrication Facility at LLNL would consist of acetone, toluene/methanol mixture, toluene, and dimethyl formamide in aqueous solution. The toluene/methanol waste stream has been evaluated as a strong candidate for recycling by distillation to recover the high value solvent components. The distillation of this waste stream would result in the generation of distillation bottoms, which would be removed periodically and managed as a solid hazardous waste. Liquid hazardous wastes would be collected in DOT-approved containers and sent to an onsite hazardous waste accumulation area. The hazardous waste accumulation area would provide a 90-day staging capacity prior to shipment to an offsite commercial RCRA-permitted treatment, storage, and disposal facility, using DOT-certified transporters. After compaction, if appropriate, the solid hazardous wastes would be packaged in DOT-approved containers and sent to a hazardous waste accumulation area for staging, characterization, and packaging prior to shipment to an offsite commercial RCRA-permitted treatment, storage, and disposal facility using DOT-certified transporters.

Nonhazardous (Sanitary) Waste. Nonhazardous waste generated by the Nonnuclear Fabrication Facility at LLNL primarily consists of process water and incidental water usage, and nonrecyclable, nonhazardous solid sanitary and industrial wastes. Liquid sanitary wastes would be collected by sewer pipe systems from most of the support buildings and discharged directly to the city of Livermore municipal sanitary sewer system. One of the projected waste streams, an aqueous solution of urea, will be sampled to establish a baseline of waste stream constituents, and directed to the sanitary sewer system. Process wastewater is sent to holding tanks for treatment and recycled where appropriate. Process rinsewater waste streams are pretreated and then discharged to the sanitary sewer system

TABLE A.3.6.3–8.—*Lawrence Livermore National Laboratory Nonnuclear Fabrication Waste Volumes*

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations[a] (m^3)	Annual Volume Effluent from Surge Operations (m^3)
Hazardous			
Liquid	0.08	7[b]	3[c]
Solid	0.15	None	0.2
Nonhazardous (Sanitary)			
Liquid	36	5,770[d]	5,770[e]
Solid	0.9	127[f]	64[g]
Nonhazardous (Other)			
Liquid	76	Included in sanitary	Included in sanitary
Solid	10	Included in sanitary	Included in sanitary

[a] With the exception of sanitary wastes, the data for a multiple shift were determined by multiplying the single-shift values by 2.5.

[b] Data were provided as 2,500 lb of acetone, 3,500 lb of toluene/methanol, 250 lb of toluene, and 270 lb of dimethyl formamide. Assuming a density of 1,000 kg/cubic meter, these were converted to cubic meters.

[c] Assumes toluene/methanol wastestream would be recycled by a distillation process. Five percent of the toluene/methanol volume is assumed for the distillation bottoms which appear as a solid waste effluent.

[d] No data provided for liquid sanitary wastes such as sewage. Assumed 50 gal per day per person, 250 days per year operation. Number of employees used is 47.5. The urea waste stream was multiplied by 2.5. The rest of the sanitary waste was multiplied by 2.4 for three shifts.

[e] LLNL does not treat sanitary wastewater as it goes to the municipal sanitary sewer system; thus the effluent is the same as generated.

[f] No data provided for solid sanitary wastes such as housekeeping trash. Assumed 0.3 ft^3 per day per person, 250 days per year operation. Number of employees used is 47.5, which was multiplied by 2.4 to get three shifts.

[g] Assumes that 2/3 of the solid waste is compactible by a factor of 4:1.

Source: LLNL 1995f; LLNL 1995i:2.

according to permit requirements and the city of Livermore Public Services Ordinance.

Nonhazardous (Other) Waste. The bulk of waste would be thermoplastic and cured thermoset materials and various fillers or reinforcements. LLNL is conditionally permitted in California to treat any unused thermosetting waste in order to make the waste nonhazardous. Stormwater from areas of LLNL is allowed to go in natural drainage channels.

A.3.6.4 *Relocate to Sandia National Laboratories*

Most products and services currently obtained from KCP would be obtained by SNL, which is located in New Mexico, through procurement from the commercial sector or through capabilities that would be developed internal to SNL. Procurement of products and services from the private sector would be the preferred alternative. Key nonnuclear product and process descriptions for items to be purchased are described in the following section.

System Level Products (Made up of more than one component to form a kit or system.)

Retrofit Kits. Retrofit kits would be assembled, stored, packaged, and shipped to various locations for repairing problems in weapons or upgrading weapon capabilities. Retrofit kits would be maintained in a bonded storage area, and when complete would be specially packaged and shipped to where they are needed. Sometimes specialty packaging would be done at the fabrication point within the plant.

Trainer Kits. Trainer kits are a package that may contain a variety of weapon components that may be hazardous or operationally irreversible in their realistic form but are functional in helping to teach

the customer how to test, operate, or install a real component prior to actually doing so. Alternately, the kit may be used to teach the customer how to perform a weapon retrofit. The trainer kit may also contain tools, test devices, bolt packs, or similar hardware packs to perform tests or component replacement training. Trainer kits would be made in-house for components that are made in-house.

SECOM Relay Station. DOE currently maintains five high frequency relay station facilities around the country in support of its redundant secure communications network. KCP has maintained the high frequency relay station physically located south of KCP for nearly 20 years. Current responsibilities include upkeep of the grounds including security fencing, mowing, building repair, generator repair, and maintenance of the computers, transmitters, receivers, and antenna field.

Electrical Components

Hybrid Microcircuit Substrates. Ceramic substrates with conductor patterns are needed to support assembly of circuits for radar units. These substrates would be purchased to meet the circuit layout specifications.

High Energy Density Capacitors and Passives: Ceramic Capacitors, Resistors, and Filters. This group of components includes high energy density capacitors and all passive electrical components such as capacitors, resistors, and filters.

Integrated Circuits and Semiconductor Components. These components include the full range of all the semiconductor products including diodes, transistors, and large-scale integrated circuits used in war reserve assemblies.

Joint Test Assembly Components. These are telemetry components used on joint test assemblies that are all procured from outside suppliers. They include pulse code modulators, voltage controlled oscillators, a mixer amplifier, a crystal oscillator, transmitters, and transponders.

Printed Wiring Products. This group of products consists of a wide variety of items processed in the printed wiring facility at KCP. These products range from rigid multilayer boards, multilayer flex, and special material boards to polyimide quartz boards, detonator cables, and chem-milled products used to fabricate rolamites.

Interconnects Cable Fabrication. Cable fabrication includes round wire, flat flex, and radio frequency types of cables.

Junction Boxes. Junction boxes are used to electrically connect internal weapons components to each other and the weapon control panel. The junction box has many lines and some components internally wired to several connectors at the junction box surface. The various weapon components are then attached with cables to the junction box connectors as the weapon is being assembled.

Mechanical Components

Transducers. Transducer components consist of pressure transducers, accelerometers, rate gyro assemblies, and temperature piezoelectric transduces.

Radio Frequency and Multicontact Connectors. The radio frequency multicontact connector product category includes all electrical connectors used on all weapons programs. The primary next-assemblies for the radio frequency and coaxial connectors are radars, antenna systems, and system-level coaxial cable assemblies. The multipin connectors are used throughout systems on firesets, radars, and programmers, in addition to being used for system-connect cables.

Handling Gear. Weapon systems require specially designed equipment for handling, lifting, and transportation called handling gear. There are two distinct types of handling gear: team gear and ultimate user package gear. Team gear is designed by SNL and is purchased by DOD. Ultimate user package gear is typically designed by SNL for DOE; thus, DOE owns and maintains it. Ultimate user package gear normally consists of shipping and storage containers and bomb hand trucks.

Piezoelectric Motors. Miniature piezoelectric motors are currently being developed to replace solenoids in some applications.

Molded Plastic Parts. There are 550 to 650 molded plastic parts in weapon systems. Approximately 60 percent of the parts contain inserts that are molded in place. Most of the parts are transfer-molded, with some compression-molded and some injection-molded.

Major Mechanical Parts. Major mechanical parts are nonfunctional structural components. Most of these parts will be machined metal components, but they could also be components fabricated from plastics, ceramics, or sheet metal.

O-rings, Cushion, and Gaskets. O-rings are used extensively in maintaining environmental and functional seals in most nuclear weapons systems. There are many types of materials available to compensate for the effects of temperature changes and materials compatibility within the weapon system.

Honeycomb Parts. Honeycomb components are used for structural purposes and shock mitigation in some nuclear weapons systems.

Parachute Assemblies. Parachute assemblies consist of four major components: the parachute tube and end, the parachute, the reefing line cutter, and the explosive deployment component. The parachute tube is a machined component. In some systems, a pilot parachute and ejection plate are used in place of a tube.

Commercial Hardware. Commercial hardware encompasses all the small hardware items used to support weapon builds, limited-life component exchanges, and stockpile maintenance. This includes screws, bolts, nuts, and other fasteners, as well as other commercially available parts.

Precision Machining. Precision machining is a service required for numerous products currently manufactured at KCP. Various machining processes are already available at SNL that could be utilized in support of war reserve production activities. The local and national vendor base with precision machining capability has been well categorized in the past, and good relations with sufficient case histories are present to aid the transition from make in-house to buy outside.

Gas Transfer Systems-Buy Items. Because SNL plans to do only final assembly, testing, and acceptance of reservoirs, there would be significant procurement of piece parts and subassemblies. All electro-explosive valves and interconnect tubing and fittings would be procured from commercial suppliers. Similarly, all machined reservoir components from hemispheres, caps, stems, sleeves, and forgings would be machined by private industry. Currently, buy items such as nuts, bolts, washers, protective caps, and raw material for forgings will continue to be procured commercially.

Materials/Explosives/Other

Detonator Cables. Detonator cables (nonprimary) consist of a header that contains the electrical wire leads and the bridge wire. Header material may vary from plastic to a metal/ceramic combination. The electric connection may be hookup wire leads, coaxial, or multipin assembly.

Military Base Spare. Military base spares are kits that DOE is required to provide to the military to maintain nuclear weapons. Currently, about 140 different kits are supplied with approximately 50 percent of the items consisting of off-the-shelf hardware and 50 percent being limited-shelf-life chemicals.

Nuclear-Grade Materials. Nuclear-grade materials comprise special controlled chemistry wrought product (bar and plate stock) used for critical and noncritical applications. This encompasses special specification materials for gas transfer systems as well as commercial grade materials for structural and nonstructural applications.

The only products to be assembled or manufactured at SNL would be those that have exceptional security requirements or that employ technologies unavailable in the commercial sector. The principal activity at SNL would be the assembly of piece parts and subassemblies procured from the commercial sector, and manufacture and assembly of those components with special security requirements. Key nonnuclear product and program descriptions for items to be manufactured in-house are described in the following sections.

System Level

Arming, Fuzing, and Firing Assembly. This process is the final assembly of the arming, fuzing, and firing subsystems. This major hardware assembly is composed of printed wiring boards, battery pack, various electronic components, connectors, wiring harness, other materials, and outer containers. All are assembled in a precise step-by-step process to meet rigid final assembly requirements. The arming, fuzing, and firing assembly is a complex process involving many different activities, supporting equipment, and personnel skill sets to achieve product realization. It is not expected that the SNL assembly process would be markedly different from that employed at KCP.

Nose Assemblies. Nose assembly includes both new-build and refurbishment assemblies. The nose assembly process is straightforward and involves several different activities, supporting equipment, and personnel skill sets.

Joint Test Assemblies. Joint test assemblies consist mainly of internal power supplies, signal conditioning, circuitry, neutron and/or x-ray detectors, and analog and digital circuitry to process data during DOE test flights. This data is transmitted to ground stations or stored in an internal data recorder for recovery after the flight.

Safeguards Transporter. The safeguards transporter new-build activity integrates both new and proven security and safety technologies into a modern transport design that will ultimately replace the safe secure trailer. The safeguards transporter project includes developing a manufacturing capability and producing safeguards transporters. Approximately 20 percent of the production work would be done at SNL and 80 percent would be procured commercially.

Electrical Components

Lightning Arrester Connectors. Lightning arrester connectors are multicontact circular hermetic connectors that must reliably function as a connector in normal environments and must divert current from a direct lightning strike, or any other high voltage source, from the connector contacts to the connector shell. A lightning arrester connector is made from commercially manufactured connector shell and piece parts, combined with specially formulated granules. The special granules give the lightning arrester connector its lightning protection capability.

Firesets Capacitor Discharge Unit Firing Systems. The primary purpose of a capacitor discharge unit firing system is to provide the timing and initiation power for the weapon electrical system. The firing systems also provide the packaging for other weapon components depending on the specific requirements. Hence, firing systems use low and high voltage circuits, power and voltage switches, stronglinks, regulators, and related circuitry. The processes currently in use at KCP would continue much the same at SNL except that more parts would be commercially procured.

Radars. The following list briefly outlines the required processes:

- Radio frequency and printed wiring assembly: kitting of parts, circuit board population, belt/hand soldering, cleaning, laser marking, final visual/electrical inspection
- Channel assembly: install logic/converter and radio frequency assemblies, attach flex, cables, clean, first visual/electrical inspection, temperature cycle, encapsulate, final visual/electrical inspection
- Radar assembly: select two channels, first electrical, install desiccant and compression pad, laser weld channels, first leak test, purge and backfill, weld evacuated tubes, final leak test, laser mark, final visual/electrical inspection
- E-test/D-test: short/medium term vibration, shock, temperature cycling, electrical test, dissection

Antennas. The process of antenna manufacturing consists of machining, welding, and plating a housing. Feed network component parts are assembled into the housing and welded together. A dielectric is sealed into the housing, and the assembly is leak tested. The completed assembly then undergoes an environmental preconditioning (temperature cycling). The antenna is then radio

frequency tested on a ground plane in an anechoic chamber. Samples are pulled periodically and undergo test environments to ensure product and process reliability.

Use Control Hardware. All use control hardware would be manufactured in-house. In some cases, commercial parts would be used. All repair of use control hardware would also be performed in-house.

Mechanical Components

Gas Transfer Systems. Gas transfer systems include high pressure reservoirs for containing either boost or inert working gases, explosive valves to open the reservoirs, and tubulations and connectors to transfer the contained gases to required locations within the weapon. Electro-explosive valves are used to accomplish several functions including opening and closing gas flow paths and/or diverting gas flow. SNL currently possesses reservoir production capability but without sufficient capacity. The fabrication process begins with commercial vendor-supplied metal forgings made from certified controlled chemistry bar stock material procured by SNL. Piece parts and subassemblies would be qualified and certified at the vendor by SNL personnel. Final reservoir assembly, primarily welding, would be conducted at SNL along with final inspection and testing. The only machining done at SNL would be post-welding dressing to achieve final contours in the welded areas. Final certification, including volume measurement and proof testing, packaging, and shipping, would be an SNL responsibility.

Desiccants and Getters. Desiccants are made of molded materials that combine epoxies, curatives, and zeolite desiccant material. Getters are organic compounds that are mixed with a catalyst and binder. Getters and desiccants are used to control environments in weapon systems. SNL would use the current KCP processes.

Process Support Systems. Process support systems include capabilities and facilities that are used to support production activities across a wide variety of product lines. These range from general, commonly used services such as materials characterization, and analysis, and environmental and nondestructive testing, to more specialized support such as failure analysis and reliability physics for semiconductor devices, and metrology. While the general activity transfer philosophy is to purchase goods and services from commercial sources wherever possible, the approach with the services and support systems described here is to meet requirements by building upon SNL's existing capabilities. In almost all cases, these capabilities must be maintained in order to meet SNL traditional missions. In addition, particularly for analytical and testing services, the wide spectrum of required tests coupled with the large capital expenditure for testing instrumentation makes commercial availability of these services uncommon.

The alternative for siting nonnuclear production facilities in New Mexico at SNL calls for providing a new stand-alone production site. New production facilities would be provided near an existing Technical Area. Figure A.3.6.4–1 indicates location of technical areas at SNL. The new site (figure A.3.6.4–2) would be independent of the existing technical areas, but would be connected to the area's utility network. The new construction would total approximately 58,060 m^2 (625,000 ft^2) which would be located on 9 ha (22 acres) of available land. In addition to major renovation projects, some existing buildings would undergo minor modifications to accept the new workload. These minor modifications would yield an additional 5,110 m^2 (55,000 ft^2) of work space. Table A.3.6.4–1 lists key facilities. A description of the key nonnuclear fabrication facilities is discussed in the following section.

Office and Distribution Center. Standard open-bay office setup with modular furniture, break areas, files and reproduction areas, conference rooms, secure storage, and executive offices. This space would also include a visitor entry way, an equipment room, and a communications room.

Distribution Center Facility. This would be a standard environmentally controlled warehouse with an administrative office section. Space would include an equipment and communications room.

Electronic Assembly Facility. This facility would include electronic assembly, clean room, and heavy lab capability. Its modules would contain clean rooms, screen room, conductive flooring, special temperature and humidity areas, and assembly areas. The space would include a chemical and materials handling and distribution area, an equipment room, and communications room.

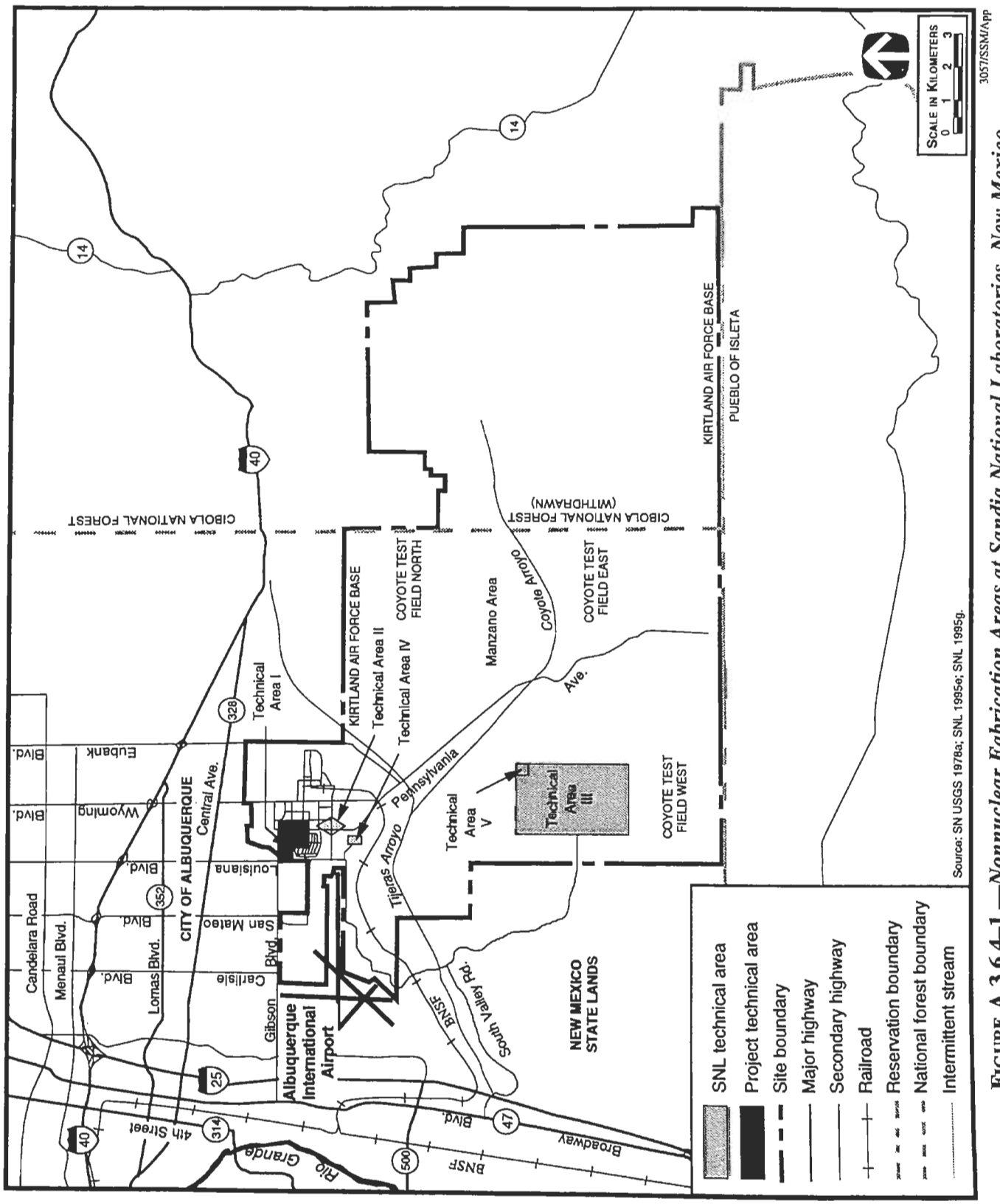


FIGURE A.3.6.4–1.—*Nonnuclear Fabrication Areas at Sandia National Laboratories, New Mexico.*

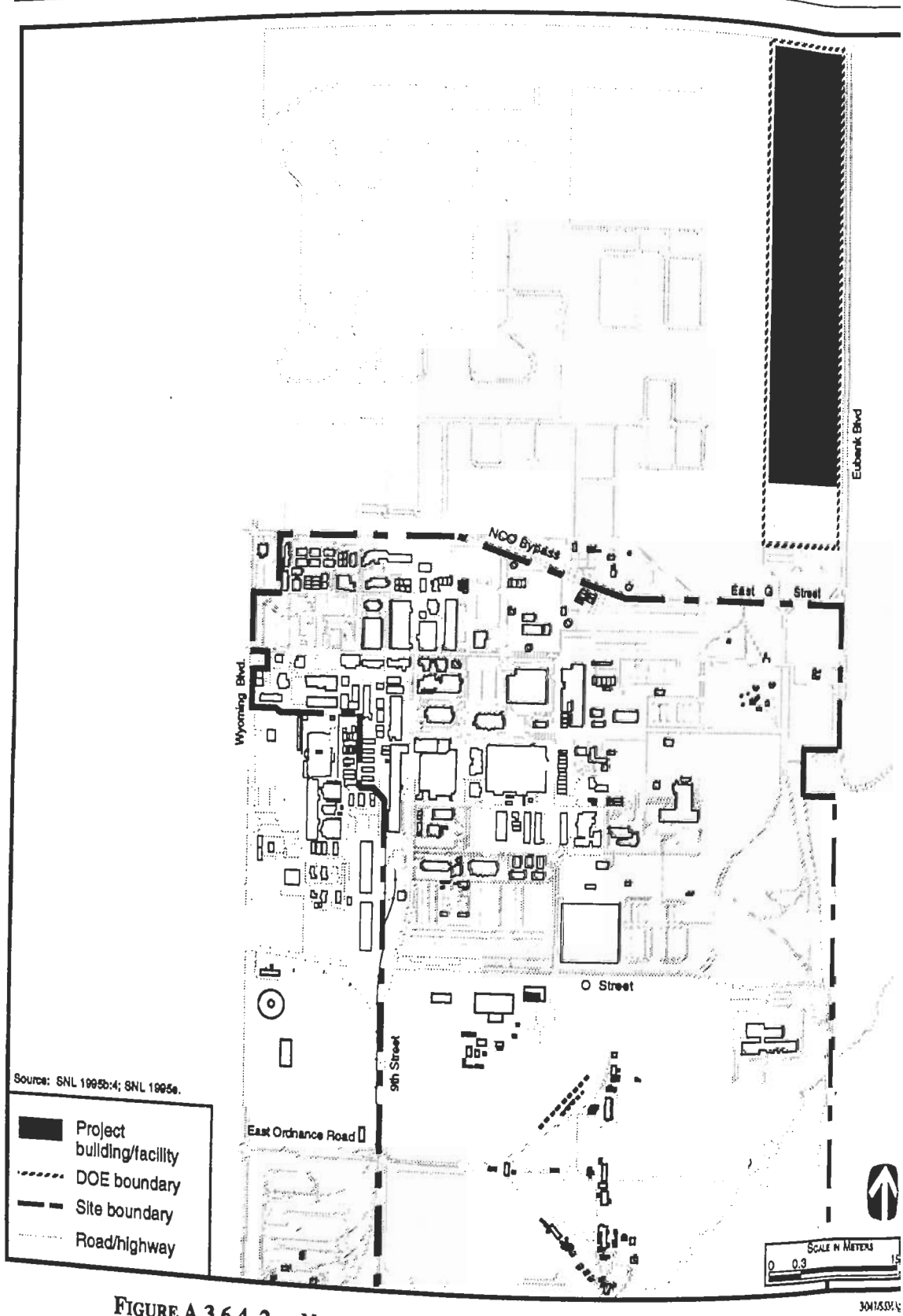


FIGURE A.3.6.4–2.—*Nonnuclear Fabrication Facility Plot Plan at Sandia National Laboratories.*

Mechanical Assembly Facility. This facility would include a high bay, heavy lab, mechanical assembly, clean room, and some offices. It would also contain a precision machine shop with forges, presses, ovens, and other metal-forming and metal-treating equipment, mechanical assembly areas, and clean room areas. Space would include an equipment room and a communications room.

TABLE A.3.6.4–1.—*Sandia National Laboratories Nonnuclear Fabrication Facility Data*

Facility	Floor Space (m^2)
Office facility	10,219
Distribution center facility	12,277
Electronics assembly facility	16,537
Mechanical assembly facility	6,225
Special production facility	5,574
Central utility building	929
Existing building modifications	5,110
Additional contingency space	4,645
Total	61,316

Source: SNL 1995e.

Special Products Facility. The space would include a high bay, heavy lab, electrical assembly, mechanical assembly, clean room, equipment and communications room. This facility would also have a vault-type security system for controlled areas.

Central Utility Building. In addition to the central chiller and other utilities, this facility would serve as the maintenance headquarters for the site. It would contain offices, records storage, and an emergency management center.

Construction activities would consume electrical power, potable and construction water, and fuel for heavy construction equipment. Emissions generated during construction would include vehicle exhausts and fugitive dust from land clearing and other construction operations. Wastes generated during construction would consist of wash water, construction debris, scrap materials, and hazardous materials such as lead paint and asbestos collected during renovation of older buildings. A list of materials and resources consumed during construction can be found in table A.3.6.4–2.

The number of construction personnel can be found in table A.3.6.4–3.

TABLE A.3.6.4–2.—*Sandia National Laboratories Nonnuclear Fabrication Construction Materials/Resources Requirements*

Material/Resource	Total Consumption	Peak Demand
Electricity	46.8 MWh	2.5 MWe
Fuel (L)	2,600,000	
Water (L)	2,200,000	
Concrete (m^3)	12,800	
Steel (t)	5,440	
Industrial Gases	NA	

Note: NA - not applicable.
Source: SNL 1995b:5; SNL 1995e.

TABLE A.3.6.4–3.—*Sandia National Laboratories Nonnuclear Fabrication Construction Workers*

	Personnel Required			
Employees	Year 1	Year 2	Year 3	Total
All crafts and laborers	120	320	200	640
Supervisors and foremen	10	23	16	49
Office and support	20	26	20	66
Inspectors	8	10	8	26
Total Employment	158	379	244	781

Source: SNL 1995e.

Utilities consumed during operation would include electric power; natural gas-fired and/or central-plant steam heat, potable, fire protection, irrigation, and process hot/chilled water; clean dry air; and sanitary sewer. The central steam plant is fired by commercially purchased natural gas. Electric power is purchased from the local utility, who generates it from coal-fired plants augmented by a natural-gas fired peak-power plant. Water is pumped electrically from wells. The other utilities are produced through the use of electrical power. The actual consumables used by SNL directly, therefore, are electricity, natural gas, and water. The surge operation utilities usages are listed in table A.3.6.4–4. A list of annual chemical use during operation can be found in table A.3.6.4–5.

Emissions from the complex during operations would include exhaust from vehicles and small quantities of aromatic hydrocarbon solvents, alcohols, and related chemistry. Usage quantities of these chemicals preclude any possibility of emissions greater than the 9.1 t (10 tons) per year threshold for *Clean Air Act* 1990 amendments. A list of these emissions can be found in table A.3.6.4–6.

TABLE A.3.6.4–4.—*Sandia National Laboratories Nonnuclear Fabrication Surge Operation Annual Utility Requirements*

Utility	Consumption	Peak Demand[a]
Electricity	39,700 MWh	6.2 MWe
Liquid fuel	0	
Natural gas[b] (m^3)	3,270,000	
Raw water (L)	893,000,000	

[a] Peak demand is the maximum rate expected during any hour.
[b] Cubic meters measured at standard temperature and pressure.

Source: SNL 1995b:4; SNL 1995b:5; SNL 1995e.

TABLE A.3.6.4–5.—*Sandia National Laboratories Nonnuclear Fabrication Surge Operation Annual Chemical Requirements*

Chemical	Quantity
Nitrogen	
Gas (m^3)	3,270
Liquid (L)	14,900,000
Argon	
Gas (m^3)	4,830
Liquid (L)	236,000
Carbon dioxide	
Gas (m^3)	322
Liquid (L)	121,000
Hydrogen	
Gas (m^3)	0.1
Helium	
Gas (m^3)	883
Liquid (L)	1,650

Source: SNL 1995b:4.

Waste Management. The solid and liquid nonhazardous wastes generated during construction would consist of the collection and ponding of wash water,

TABLE A.3.6.4–6.—*Sandia National Laboratories Nonnuclear Fabrication Surge Operation Annual Emissions*

Pollutant	Quantity (t)
Acetone	0.44
Carbon monoxide	13.17
Chromium	<0.01
Cyanide	0.01
Ethyl benzene	0.05
Formaldehyde	<0.01
Hydrochloric acid	0.03
Isopropyl alcohol	1.62
Methanol	0.01
Methyl ethyl ketone	0.16
Methyl isobutyl ketone	0.03
Particulate matter	1.03
Perc	0.29
Sulfur dioxide	0.35
Toluene	0.50
Toluene diisocyanate	<0.01
1,1,1-Trichloroethane	0.04
Trichloroethylene	2.60
Volatile organic compound	1.9
Xylene	0.26

Source: SNL 1995b:4.

landfilling of construction debris and scrap materials (especially from the renovation of existing buildings), and collection and disposal of hazardous materials (primarily asbestos and lead paint) during renovation of older buildings. The nonhazardous wastes generated during construction would be disposed of as part of the construction project by the contractor. Uncontaminated wastewater would be used for soil compaction and dust control, and excavated soil would be used for grading and site preparation. Wood, paper, and metal wastes would be shipped offsite to a commercial contractor for recycling. Hazardous wastes generated during construction would consist of such materials as waste adhesives, oils, cleaning fluids, solvents, and coatings. Hazardous waste would be packaged in DOT-approved containers and shipped offsite to commercial RCRA-permitted treatment, storage, and disposal facilities. No radioactive waste would be generated during construction.

The project design considers and incorporates waste minimization and pollution prevention. To facilitate waste minimization, where possible, nonhazardous materials would be substituted for those materials which contribute to the generation of hazardous waste. Production processes would be configured with minimization of waste production given high priority. Material from the waste streams would be treated to facilitate disposal as nonhazardous wastes, where possible. Future D&D considerations have also been incorporated into the design.

Table A.3.6.4–7 presents the estimated annual waste volumes from the Nonnuclear Fabrication Facility at SNL during construction and surge operations. Solid and liquid wastestreams are routed to the waste management system. Solid wastes would be characterized and segregated into hazardous or nonhazardous wastes, then treated to a form suitable for disposal or storage within the facility. Liquid wastes would be treated onsite to reduce hazardous/toxic elements before discharge or transport. All fire sprinkler water discharged in process areas is contained and treated as process wastewater, when required.

No new wastestreams would be generated. Wastes from the complex would include metal and dielectric material machining chips and turnings, solder scrap, acids and other eychants, curing compounds for various electrical encapsulants, test and analytical reagents, hydraulic fluid and other machine servicing compounds, reverse-osmosis backflush water, silicon slurries and other wastes generated as part of integrated circuit manufacture, sanitary sewer flows, and related materials.

Transuranic Waste. The Nonnuclear Fabrication Facility at SNL would not generate any TRU waste.

Low-Level Waste. The Nonnuclear Fabrication Facility at SNL would not generate any LLW.

Mixed Low-Level Waste. The Nonnuclear Fabrication Facility at SNL would not routinely generate any mixed LLW.

Hazardous Waste. Hazardous wastes generated by the Nonnuclear Fabrication Facility at SNL would consist of acids and other etchants, curing compounds, solvents, test and analytical reagents, and other wastes generated as part of integrated circuit manufacture. Liquid hazardous wastes would be collected in DOT-approved containers and sent to an onsite hazardous waste accumulation area. The hazardous waste accumulation area would provide a 90-day staging capacity prior to shipment to an offsite commercial RCRA-permitted treatment, storage, and disposal facility, using DOT-certified transporters. After compaction, if appropriate, the solid hazardous wastes would be packaged in DOT-approved containers and sent to a hazardous waste accumulation area for staging, characterization, and packaging prior to shipment to an offsite commercial RCRA-permitted treatment, storage, and disposal facility using DOT-certified transporters.

Nonhazardous (Sanitary) Waste. Nonhazardous liquid waste generated at the Nonnuclear Fabrication Facility primarily consists of reverse-osmosis backflush water, and sanitary sewer flows. Nonrecyclable, nonhazardous solid sanitary and industrial wastes would be compacted and disposed of in local commercial facilities. Liquid sanitary wastes would be collected by independent underground septic tanks at nonnuclear fabrication buildings and by sewer pipe systems from most of the support buildings and routed to municipal treatment facilities. Excess water is discharged to a natural drainage channel. Process wastewater is sent to holding tanks for pretreatment and screening prior to discharge to the publicly owned treatment works. The sewage wastewater would be routinely monitored for radioactive contaminants.

Nonhazardous (Other) Waste. Stormwater from areas of SNL is allowed to go in natural drainage channels.

TABLE A.3.6.4–7.—*Sandia National Laboratories Nonnuclear Fabrication Waste Volumes*

Category	Annual Average Volume Generated from Construction (m^3)	Annual Volume Generated from Surge Operations[a] (m^3)	Annual Volume Effluent from Surge Operations (m^3)
Low-Level[b]			
Liquid	None	None	None
Solid	None	None	None
Mixed Low-Level[b]			
Liquid	None	None	None
Solid	None	None	None
Hazardous			
Liquid	0.11	15	15
Solid	23	17	17
Nonhazardous (Sanitary)			
Liquid	6,160[c]	291,470	291,470[d]
Solid	236	7,880	3,940[e]
Nonhazardous (Other)			
Liquid	383[f]	Included in sanitary	Included in sanitary
Solid	5	Included in sanitary	Included in sanitary

[a] The data for a multiple shift were determined by multiplying single-shift data by 2.

[b] LLW or mixed LLW would not be generated during normal operations. However, upset conditions may result in the generation of minimal quantities of LLW or mixed LLW.

[c] No data provided. Assumes 25 gallons per day per construction worker for 250 days per year and 260 construction workers. Construction toilets are trucked off site for servicing.

[d] SNL sanitary wastewater goes to the city of Albuquerque sanitary sewer system; thus the effluent is the same as generated.

[e] Assumes that 2/3 of the solid waste is compactible by a factor of 4:1.

[f] Includes washing from flushing mechanical systems, dust control water, and blockwork, cementitious coatings.

Source: SNL 1995b:5; SNL 1995e.

APPENDIX B

Appendix B

APPENDIX B: AIR QUALITY

B.1 INTRODUCTION

This appendix provides detailed data that support impact assessments for air quality addressed in sections 4.X.2.3, Affected Environment—Air Quality and 4.X.3.3, Environmental Impacts—Air Quality. The data presented include emission inventories from site-related activities and facility emissions for various alternatives. Section B.2 presents the methodology and models used in the air quality assessment. Section B.3 presents supporting data applicable to each site. The tables included in sections B.3.2 through B.3.9 contain site-specific information applicable to the air quality assessments at each site including figures containing wind rose data specific to each site.

B.2 METHODOLOGY AND MODELS

The assessment of potential impacts to air quality is based upon comparisons of proposed project effects with applicable standards and guidelines. The Industrial Source Complex Short-Term model, version 2, is used to estimate concentrations of pollutants from emission sources at each site.

The air quality modeling analysis performed for the alternative sites is considered a "screening level" analysis incorporating conservative assumptions applied to each of the sites such that the impacts associated with the respective alternatives could be compared among the sites. The assumptions are as follows: major source criteria pollutant emissions were modeled using actual source locations and stack parameters to determine No Action criteria pollutant concentrations; toxic/hazardous pollutant emissions were modeled from a single source centrally located within the complex of facilities on each site assuming a 10-meter (m) (32.8-foot [ft]) stack height, a stack diameter of 0.3 m (1 ft), stack exit temperature equal to ambient temperature, and a stack exit velocity equal to 0.03 m/second (s) (0.1 ft/s), unless otherwise specified.

These assumptions will tend to overestimate pollutant concentrations since no credit is given to spacial and temporal variations of emission sources. Emission sources for the facilities for each alternative were located at the same location as the existing toxic/hazardous pollutant emission sources and assumed the modeling parameters used for these emissions.

B.3 SUPPORTING DATA

B.3.1 Overview

This section presents supporting information for each of the eight existing Department of Energy (DOE) sites considered under various alternatives. Table B.3.1–1 presents the air quality standards applicable to each site. Subsequent sections present supporting information used in the air quality analysis at Oak Ridge Reservation (ORR), Savannah River Site (SRS), Kansas City Plant (KCP), Pantex Plant (Pantex), Los Alamos National Laboratory (LANL), Lawrence Livermore National Laboratory (LLNL) (which includes the Livermore Site and Site 300), Sandia National Laboratories (SNL), and Nevada Test Site (NTS).

B.3.2 Oak Ridge Reservation

This section provides information on meteorology and climatology, emission rates, modeling assumptions, atmospheric dispersion characteristics, and annual mean wind speed and direction frequencies (figure B.3.2–1) at ORR. Table B.3.2–1 presents emission source inventories for criteria and toxic/hazardous pollutants at ORR. This information supports data presented in the environmental impacts section for air quality.

Climatology and Meteorology. The wind direction above the ridge tops and within the valley at ORR tends to follow the orientation of the valley. On an annual basis, the prevailing winds at the National Weather Service station in the city of Oak Ridge are either up-valley, from west to southwest, or down valley, from east to northeast. Figure B.3.2–1 shows mean wind speeds and direction frequencies for 1990 measured at the 30-m (100-ft) level of the ORR meteorology tower. The prevailing wind directions are from the southwest and northeast quadrants. Annual mean wind speeds measured in the region are relatively low averaging 2 m/s (4.5 miles per hour

TABLE B.3.1–1.—*Ambient Air Quality Standards Applicable to the Candidate Sites* [Page 1 of 2]

Pollutant	Averaging Time	Primary NAAQS[a] (μg/m³)	Secondary NAAQS (μg/m³)	California (Livermore Site and Site 300) (μg/m³)	Nevada (NTS) (μg/m³)	Kansas (KCP) (μg/m³)	Texas (Pantex) (μg/m³)	Tennessee (ORR) (μg/m³)	Georgia and South Carolina (SRS) (μg/m³)	New Mexico (LANL/SNL) (μg/m³)
Criteria Pollutant										
Carbon monoxide	Annual	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]/4,600
	8-hour	10,000	[b]	10,000	10,000	10,000	10,000	10,000	10,000	7,689/10,000
	1-hour	40,000	[b]	23,000	40,000	40,000	40,000	40,000	40,000	11,578/15,000
Lead	Calendar quarter	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5/1.5
Nitrogen dioxide	30-day	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]/3
	Annual	100	100	100	100	100	100	100	100	73/94
	24-hour	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]	145/117
	1-hour	[b]	[b]	470	[b]	[b]	[b]	[b]	[b]	[b]/[b]
Ozone	1-hour	235	235	180	235	235	235	235	235	235/235
Particulate matter	Annual	50	50	30	50	50	50	50	50	50/50
	24-hour	150	150	50	150	150	150	150	150	150/150
Sulfur dioxide	Annual	80	[b]	80	80	80	80	80	80	40/11
	24-hour	365	[b]	105	365	365	365	365	365	202/92
	3-hour	[b]	1,300	1,300	1,300	1,300	1,300	1,300	1,300	1,300/1,300
	1-hour	[b]	[b]	655	[b]	[b]	[b]	[b]	[b]	[b]/[b]
	30-minute	[b]	[b]	[b]	[b]	[b]	1,045	[b]	[b]	[b]/[b]
State and County Mandated Pollutants										
Arsenic, Copper & Zinc	30-day	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]/10
Beryllium	30-day	[b]	[b]	0.01	[b]	[b]	[b]	[b]	[b]	[b]/0.01
	24-hour	[b]	[b]	[b]	[b]	[b]	0.01	[b]	[b]	[b]/[b]
Hydrocarbons (non-methane)	3-hour	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]/100
Hydrogen fluoride	30-day	[b]	[b]	[b]	[b]	[b]	0.8	1.2	0.8	[b]/[b]
	7-day	[b]	[b]	[b]	[b]	[b]	1.6	1.6	1.6	[b]/[b]
	24-hour	[b]	[b]	[b]	[b]	[b]	2.9	2.9	2.9	[illegible]
	12-hour	[b]	[b]	[b]	[b]	[b]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE B.3.1–1.—*Ambient Air Quality Standards Applicable to the Candidate Sites* [Page 2 of 2]

Pollutant	Averaging Time	Primary NAAQS[a] ($\mu g/m^3$)	Secondary NAAQS ($\mu g/m^3$)	California (Livermore Site and Site 300) ($\mu g/m^3$)	Nevada (NTS) ($\mu g/m^3$)	Kansas (KCP) ($\mu g/m^3$)	Texas (Pantex) ($\mu g/m^3$)	Tennessee (ORR) ($\mu g/m^3$)	Georgia and South Carolina (SRS) ($\mu g/m^3$)	New Mexico (LANL/SNL) ($\mu g/m^3$)
State and County Mandated Pollutants (Continued)										
Hydrogen sulfide	1-hour	[b]	[b]	42	112	[b]	[b]	[b]	[b]	11/4
	30-minute	[b]	[b]	[b]	[b]	42	[b]	[b]	[b]	[b]/[b]
Photochemical oxidants	1-hour	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]/20
Sulfate	24-hour	[b]	[b]	25	[b]	[b]	[b]	[b]	[b]	[b]/[b]
Sulfuric acid	24-hour	[b]	[b]	[b]	[b]	10	[b]	[b]	[b]	[b]/[b]
	1-hour	[b]	[b]	[b]	[b]	30	[b]	[b]	[b]	[b]/[b]
Total reduced sulfur	1-hour	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]	3/4
Total suspended particulates	Annual	[b]	[b]	[b]	[b]	[b]	[b]	[b]	75	60/60
	30-day	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]	90/90
	7-day	[b]	[b]	[b]	[b]	[b]	[b]	[b]	[b]	110/110
	24-hour	[b]	[b]	[b]	[b]	[b]	[b]	150	[b]	150/150
Vinyl chloride	24-hour	[b]	[b]	26	[b]	[b]	[b]	[b]	[b]	[b]/[b]

[a] The NAAQS (40 CFR 50), other than those for ozone, particulate matter, lead, and those based on average annuals, are not to be exceeded more than once per year. The ozone standard is attained when the expected number of days per year with maximum hourly average concentrations above the standard is less than or equal to one. The 24-hour particulate matter standard is attained when the expected number of days with a 24-hour average concentration above the standard is less than or equal to one. The annual arithmetic mean particulate matter standard is attained when the expected annual arithmetic mean concentration is less than or equal to the standard. The calendar quarter lead standard is not to be exceeded.

[b] There is no standard.

Note: NAAQS - National Ambient Air Quality Standard.

Source: 40 CFR 50; CA EPA 1993a; MO DNR 1994a; NM EIB 1996a; NV DCNR 1995a; SC DHEC 1992b; TN DEC 1994a; TX ACB 1987a; TX ACB 1993a; TX NRCC 1992a.

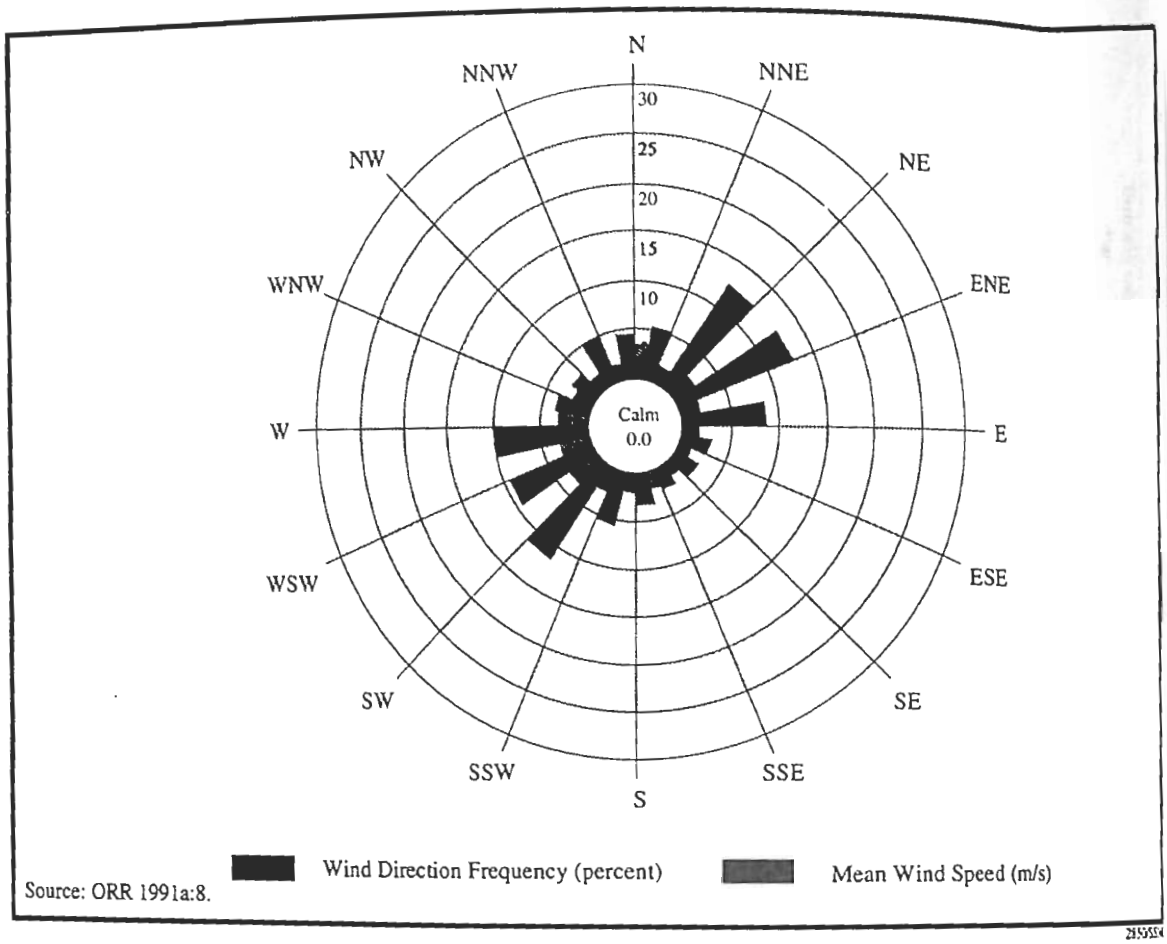


FIGURE B.3.2–1.—*Wind Distribution at Oak Ridge Reservation, 1990.*

at the Oak Ridge National Weather Service station at the 14-m (46-ft) level and 2.1 m/s (4.7 mph) at the ORR Bethel Valley monitoring station at the 10-m (32.8-ft) level. The average annual temperature at ORR is 13.7 Celsius degrees (°C) (56.6 degrees Fahrenheit [°F]); temperatures vary from an average daily minimum of -3.8 °C (25.1 °F) in January to an average daily maximum of 30.4 °C (86.7 °F) in July. Relative humidity readings taken 4 times per day range from 51 percent in April to 92 percent in August and September (NOAA 1994c:3).

The average annual precipitation measured at ORR in Bethel Valley is 131 centimeters (cm) (56.1 inches [in]), while the average annual precipitation for the Oak Ridge National Weather Service station is 136.4 cm (53.77 in). The maximum monthly precipitation recorded at the Oak Ridge National Weather Service station was 48.9 cm (19.27 in) in July 1967, while the maximum rainfall in a 24-hour period observed was recorded in August 1960 at 19 cm (7.48 in). The average annual snowfall as measured at the Oak Ridge National Weather Service station is 24.9 cm (9.8 in) (NOAA 1994c:3).

Damaging winds are uncommon in the region. Peak gusts recorded in the area range from 26.8 to 30.8 m/s (60 to 69 mph) for the months of January through July; from 21.9 to 26.8 m/s (49 to 60 mph) for August, September, and December; and 16.1 to 20.1 m/s (36 to 45 mph) in October and November (ORNL 1982a:2-72). The fastest mile wind speed (the 1 mile [mi] [1.6 kilometer {km}]) passage of wind with the highest speed for the day) recorded at the Oak Ridge National Weather Service station for the period of record 1958 through 1979 was 26.4 m/s (59.1 mph) in January 1959 (NOAA 1994c:3).

The extreme mile wind speed at a height of 9.1 m (30 ft) that is predicted to occur near ORR once in 100 years is approximately 39.8 m/s (89 mph). The approximate values for occurrence intervals of 10, 25, and 50 years are 28.6, 32.6, and 34.0 m/s (64, 73, and 76 mph), respectively (ORNL 1981a:3.3-7).

Between 1916 and 1972, there were 25 tornadoes reported in the counties of Tennessee having borders within about 64.4 km (40 mi) of ORR. The probability of a tornado striking a particular point in the vicinity of ORR is estimated to be 3.6×10^{-4} per year (ORNL 1982a:2-125).

On February 21, 1993, a tornado passed through the northeastern edge of ORR and caused considerable damage to a number of structures in the nearby Union Valley Industrial Park. Damage from this tornado to ORR was relatively light. The wind speeds associated with this tornado ranged from 17.9 m/s (40.0 mph) to those approaching 58.1 m/s (130 mph) (OR DOE 1993c:iii).

Emission Rates. ORR exceeds the applicable 250-ton-per-year emissions criterion for nitrogen dioxide and sulfur dioxide and is therefore classified as an existing major source for these pollutants. The classification of ORR as a major source may require further prevention of significant deterioration review than sites not classified as a major source. Table B.3.2–1 presents the emission rates for criteria and toxic/hazardous pollutants at ORR. These emission rates were used as input into the Industrial Source Complex Short-Term model, version 2, to estimate pollutant concentrations.

Modeling Assumptions. Additional model input used to estimate maximum pollutant concentrations at or beyond the ORR site boundary include the following: criteria pollutant emissions were modeled from actual stack locations using actual stack heights, stack diameter, exit velocity, and exit temperature, taken from operating permits; toxic/hazardous pollutant emissions were modeled from a centrally located stack in the Y-12 Plant (Y-12) complex at a height of 10 m (32.8 ft), stack diameter of 0.3 m (1.0 ft), exit velocity of 0.03 m/s (0.1 ft/s), and exit temperature equal to ambient temperature.

TABLE B.3.2–1.—*Emission Rates for Proposed Management Alternatives at Oak Ridge Reservation*

Pollutant	2005 No Action (kg/yr)	Downsize Secondary and Case Fabrication (kg/yr)[a]	Phaseout of Secondary and Case Fabrication (kg/yr)
Criteria Pollutant			
Carbon monoxide	95,000	89,500	(12,900)
Nitrogen dioxide	870,000	708,000	(357,000)
Particulate matter	8,300	7,930	(870)
Sulfur dioxide	972,000	904,000	(148,000)
Total suspended particulates	1,125,000	1,025,000	(110,000)
Hazardous and Other Toxic Compounds			
Acetic acid	1	1	(1)
Chlorine	1,750	1,740	(160)
Hydrogen chloride	6,420	5,480	(5,740)
Hydrogen fluoride	70	70	(70)
Hydrogen sulfide	[b]	[b]	[b]
Methyl alcohol	26,400	16,600	(23,800)
Nitric acid	9,500	8,100	(8,500)
Sulfuric acid	2,500	2,120	(2,180)
1, 1, 1-Trichloroethane	220	220	(200)

[a] Based upon reduction of No Action emissions.

[b] No sources indicated.

Note: Parentheses indicate a net reduction in emissions.

Source: OR DOE 1993a; OR DOE 1995g.

Atmospheric Dispersion Characteristics. Data collected at the ORR meteorological monitoring station (Y-12 east tower) for calendar year 1990 indicate that unstable conditions occur approximately 23 percent of the time, neutral conditions approximately 31 percent of the time, and stable conditions approximately 46 percent of the time, on an annual basis.

Annual Mean Wind Speeds and Direction Frequencies. ORR meteorological data for annual mean wind speed and direction for 1990 is presented in figure B.3.2–1 as a wind rose. As shown in this figure, the maximum wind direction frequency is from the east-northeast with a secondary maximum from the northeast. The mean wind speed from the east-northeast is 1.7 m/s (3.8 mph); from the northeast is 2.3 m/s (5.1 mph); while the maximum mean wind speed is 3.3 m/s (7.4 mph) from the southwest.

B.3.3 Savannah River Site

This section provides information on climatology and meteorology, modeling assumptions, atmospheric dispersion characteristics, and annual mean wind speed and direction frequencies (figure B.3.3–1) at SRS. Table B.3.3–1 presents emission source inventories for criteria and toxic/hazardous pollutants at SRS. This information supports data presented in the environmental impacts section for air quality.

Climatology and Meteorology. Figure B.3.3–1 shows annual mean wind speeds and wind direction frequencies for 1991 measured at the 60-m (200-ft) level of the SRS H-Area weather station. The wind data from the site indicate that there is no prevailing wind direction at SRS. The highest directional frequency is from the northeast. The average annual wind speed measured is 3.8 m/s (8.4 mph) (WSRC 1992h).

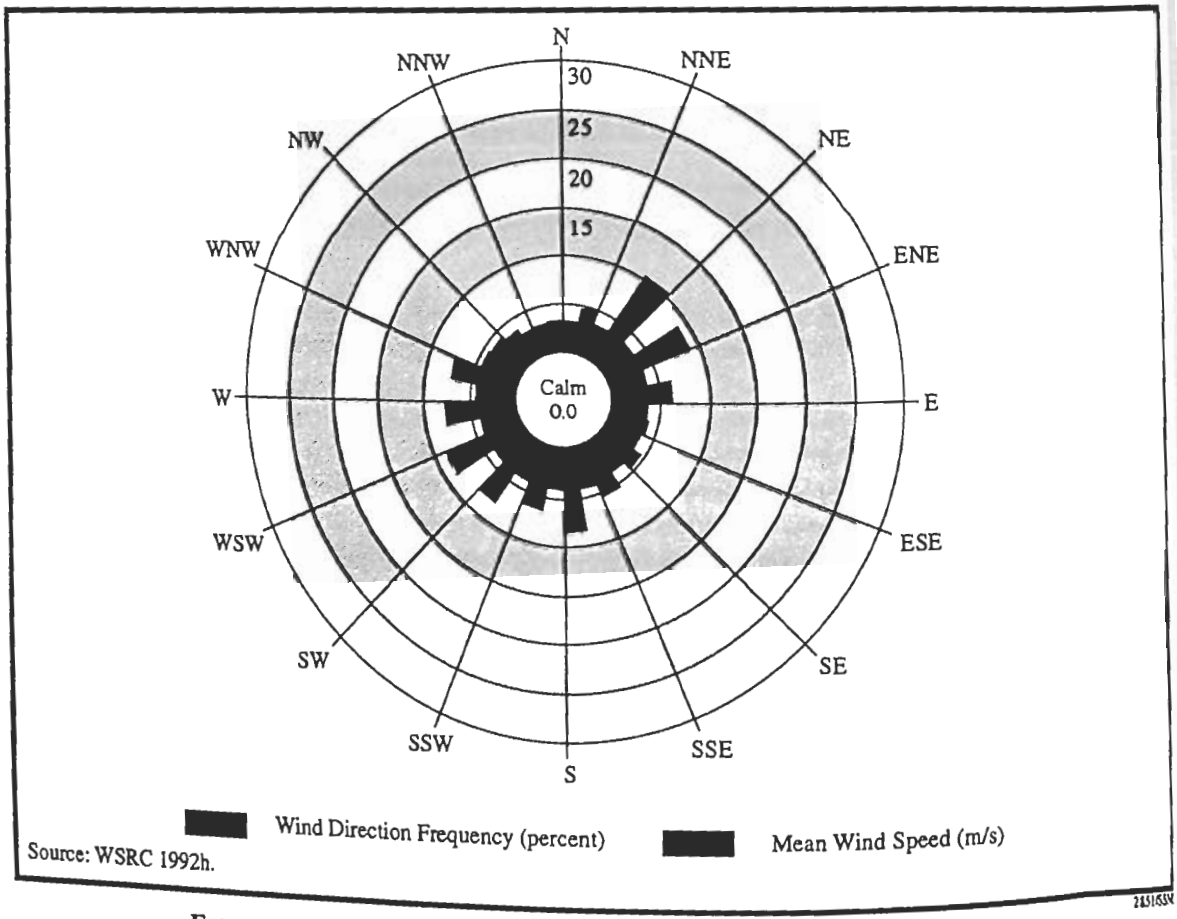


FIGURE B.3.3–1.—*Wind Distribution at Savannah River Site, 1991.*

TABLE B.3.3–1.—*Emission Rates for Proposed Management Alternatives at Savannah River Site*

Pollutant	2005 No Action (kg/yr)		Pit Fabrication (kg/yr)
Criteria Pollutant			
Carbon monoxide	404,449		685
Hydrogen fluoride	16,690		[a]
Nitrogen dioxide	4,278,380		15,666
Particulate matter	1,963,180		968
Sulfur dioxide	9,454,199		32,552
Total suspended particulates	4,430,890		[a]
Hazardous and Other Toxic Compounds	**Point and Volume Source (kg/yr)**	**Area Source ($kg/yr/m^2$)**	
Acrolein	[a]	1.94×10^{-3}	[a]
Benzene	129,772.3	0.21	[a]
Bis (chloromethyl) ether	211.0	[a]	[a]
Cadium oxide	243.0	[a]	[a]
Chlorine	21,146.7	10.11	[a]
Chloroform	1,035,006	13.6	[a]
Cobalt	5,970.2	4.58×10^{-4}	[a]
3, 3-Dichlorobenzidine	211.0	[a]	[a]
Formic acid	46,949.5	[a]	[a]
Manganese	27,882.1	2.61	[a]
Mercury	917.5	1.15×10^{-3}	[a]
Nickel	23,022.5	6.02	[a]
Nitric acid	1,150,525.8	[a]	[a]
Parathion	[b]	[b]	[a]
Phosphoric acid	14,859.8	[a]	[a]

[a] No sources indicated.
[b] Data not available.
Source: SRS 1993a:4; SRS 1995a:10; WSRC 1995c.

The average annual temperature at SRS is 17.3 °C (63.2 °F); temperatures vary from an average daily minimum of 0.0 °C (32 °F) in January to an average daily maximum of 33.2 °C (91.7 °F) in July. Relative humidity readings taken 4 times per day range from 45 percent in April to 92 percent in August and September (NOAA 1994c:3).

The average annual precipitation at SRS is 113.4 cm (44.66 in). Precipitation is distributed fairly evenly throughout the year, with the highest precipitation in summer, 32.7 cm (12.87 in) and the lowest in autumn, 21.2 cm (8.34 in). Although snow can fall from November through April, the average annual snowfall is only 2.8 cm (1.1 in); large snowfalls are rare (NOAA 1994c:3).

Winter storms in the SRS area occasionally bring strong and gusty surface winds with speeds as high as 22.8 m/s (51 mph). Thunderstorms can generate winds with speeds as high as 21.5 m/s (48.1 mph) and even stronger gusts. The fastest 1-minute wind speed recorded at Augusta between 1952 and 1993 was 27.7 m/s (62 mph) (NOAA 1994c:3).

The average number of thunderstorm days per year at SRS is 56. From 1954 to 1983, 37 tornadoes were reported for a 1-degree square of latitude and

longitude that includes SRS. This frequency of occurrence amounts to an average of about one tornado per year. The estimated probability of a tornado striking a point at SRS is 7.1×10^{-5} per year. Since operations began at SRS in 1953, nine tornadoes have been confirmed on or near SRS. Nothing more than light damage was reported in any of these storms, with the exception of a tornado in October 1989. That tornado caused considerable damage to timber resources in an undeveloped wooded area of SRS (WSRC 1990b:1).

From 1899 to 1980, 13 hurricanes occurred in Georgia and South Carolina, for an average frequency of about 1 hurricane every 6 years. Three hurricanes were classified as major. Because SRS is about 160 km (99.4 mi) inland, the winds associated with hurricanes have usually diminished below hurricane force (greater than or equal to a sustained speed of 33.5 m/s (75 mph) before reaching the site (DOE 1992e:4-115).

Emission Rates. SRS exceeds the applicable 250-ton-per-year emissions criterion for carbon monoxide, nitrogen dioxide, PM_{10}, and sulfur dioxide and is therefore classified as an existing major source for these pollutants. The classification of SRS as a major source may require further prevention of significant deterioration review than sites not classified as a major source. Table B.3.3–1 presents the emission rates for criteria and toxic/hazardous pollutants at SRS. The toxic/hazardous pollutant emissions presented in the table represent those pollutants with estimated concentrations at or beyond the SRS boundary that exceed 1 percent of the state air quality standards. These emission rates were used as input into the Industrial Source Complex Short-Term model, version 2, to estimate pollutant concentrations.

Modeling Assumptions. Emission rates for criteria and toxic/hazardous pollutants were based upon site actual emissions data for the year 1990. Additional model input used to estimate maximum criteria and toxic/hazardous pollutant concentrations at or beyond the SRS site boundary include pollutant emissions modeled from actual stack heights, actual effective stack diameters, actual exit velocity, and actual exit temperature.

Atmospheric Dispersion Characteristics. Data collected at the SRS meteorological monitoring station for 1991 indicate that unstable conditions occur approximately 38 percent of the time, neutral conditions approximately 43 percent of the time, and stable conditions approximately 19 percent of the time, on an annual basis.

Annual Mean Wind Speeds and Direction Frequencies. The SRS meteorological data for annual mean wind speed and direction for 1991 is presented in figure B.3.3–1 as a wind rose. As shown in this figure, the maximum wind direction frequency is from the northeast with a secondary maximum from the east-northeast. The mean wind speed from the northeast is 3.8 m/s (8.5 mph); from the east-northeast, 3.8 m/s (8.5 mph); while the maximum mean wind speed is 4.1 m/s (9.2 mph) from the west-northwest.

B.3.4 Kansas City Plant

This section provides information on meteorology and climatology, emission rates, modeling assumptions, atmospheric dispersion characteristics, and annual mean wind speed and direction frequencies (figure B.3.4–1) at KCP. Table B.3.4–1 presents emission source inventories for criteria and toxic/hazardous pollutants at KCP. This information supports data presented in the environmental impacts section for air quality.

Climatology and Meteorology. Figure B.3.4–1 shows annual mean wind speeds and wind direction frequencies for 1991 measured at the 10-m (32.8-ft) level of the Kansas City, Missouri National Weather Service station. The wind data from the Kansas City National Weather Service station indicate that the predominant wind direction frequency is from the south. The average annual wind speed measured is 4.8 m/s (10.8 mph). Average monthly wind speeds range from 5.6 m/s (12.6 mph) in March, to 4.1 m/s (9.1 mph) in August.

The average annual temperature at KCP is 12.0 °C (53.6 °F); temperatures vary from an average daily minimum of -8.5 °C (16.7 °F) in January to a daily mean maximum of 31.5 °C (88.7 °F) in July. Relative humidity readings taken four times per day range from 53 percent in April to 86 percent in August and September (NOAA 1994a:3).

The average annual precipitation at KCP is 95.6 cm (37.62 in). The highest precipitation occurs in the

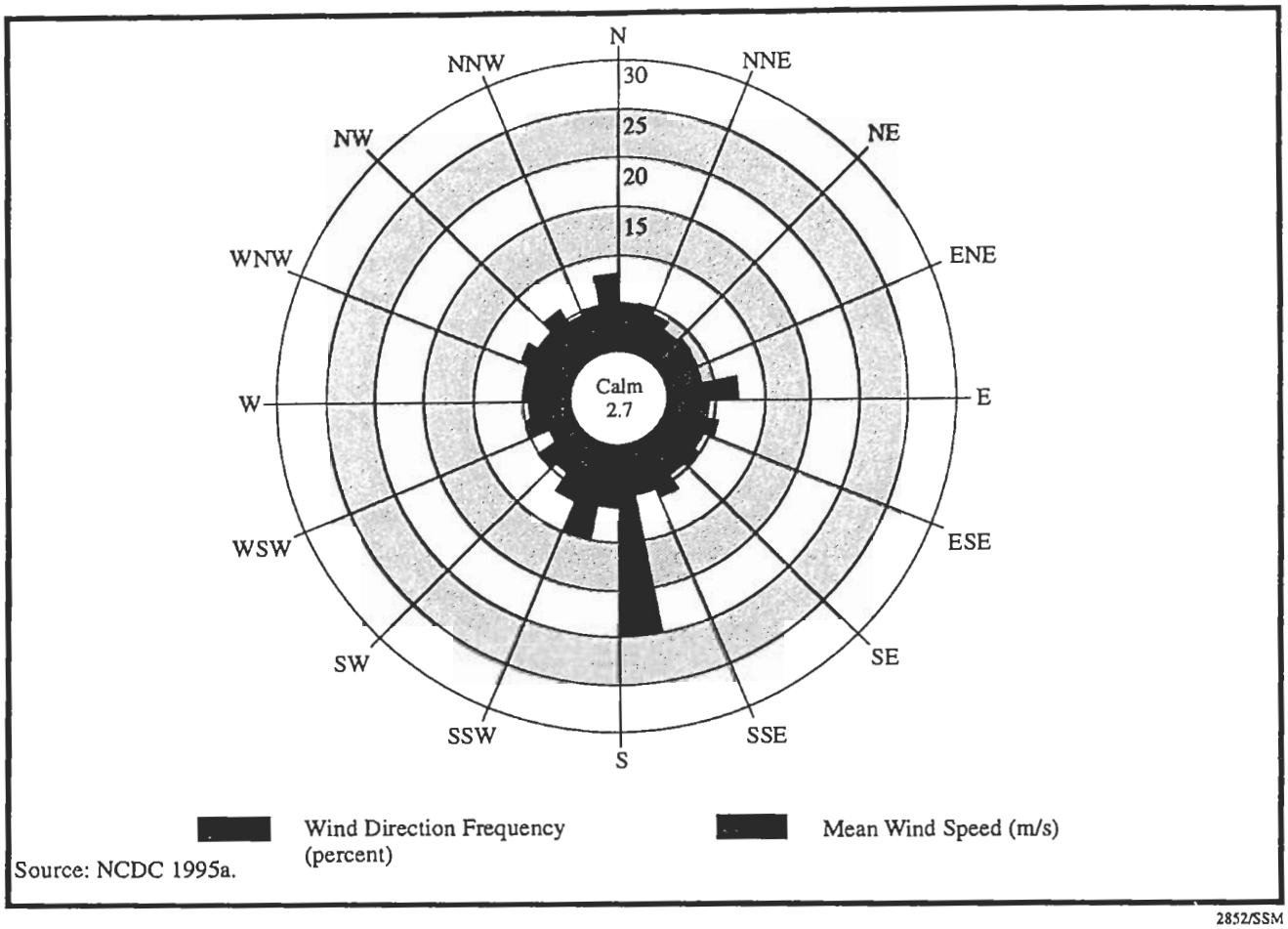


FIGURE B.3.4–1.—*Wind Distribution at Kansas City Plant, 1991.*

summer months, May through September, and the lowest in winter. Snow can fall from November through April, with the average annual snowfall being 51.1 cm (20.1 in) (NOAA 1994a:3).

Winter storms in the KCP area occasionally bring strong and gusty surface winds with speeds as high as 25.9 m/s (58 mph). Thunderstorms can generate winds with speeds as high as 33.5 m/s (75 mph) and even stronger gusts. The fastest 1-minute wind speed recorded at Kansas City National Weather Service station was 21.5 m/s (48 mph) (NOAA 1994a:3).

The average number of thunderstorm days per year at KCP is 51.8. The estimated probability of a tornado striking a point at KCP is 7.5×10^{-4} per year (NRC 1986a:32).

Emission Rates. Table B.3.4–1 presents the emission rates for criteria and toxic/hazardous pollutants at the KCP. These emission rates were used as input into the Industrial Source Complex Short-Term model, version 2, to estimate pollutant concentrations.

Modeling Assumptions. Additional model input used to estimate maximum pollutant concentrations at or beyond the KCP site boundary include the following: criteria pollutant emissions were modeled from actual stack locations using actual stack heights, stack diameter, exit velocity, and exit temperature, taken from operating permits; toxic/hazardous pollutant emissions were modeled from a centrally located stack in the KCP complex at a height of 10 m (32.8 ft), stack diameter of 0.3 m (1.0 ft), exit velocity of 0.03 m/s (0.1 ft/s), and exit temperature equal to ambient temperature.

Atmospheric Dispersion Characteristics. Data collected at the Kansas City National Weather Service station for calendar year 1991 indicate that unstable conditions occur approximately 15 percent

TABLE B.3.4–1.—*Emission Rates for Proposed Management Alternatives at Kansas City Plant*

Pollutant	2005 No Action (kg/yr)	Downsize Nonnuclear Fabrication (kg/yr)	Phaseout of Nonnuclear Fabrication (kg/yr)
Criteria Pollutant			
Carbon monoxide	11,948	11,948	(11,948)
Nitrogen dioxide	42,574	42,574	(42,574)
Particulate matter	934	934	(934)
Sulfur dioxide	318	318	(318)
Total suspended particulates	934	934	(934)
Hazardous and Other Toxic Compounds			
Acetone	399	416	(399)
Chromium	<9	<9	(<9)
Cyanide	10.21	5.22	(10.21)
Ethyl benzene	45.4	45.4	(45.4)
Formaldehyde	<9	<9	(<9)
Hydrogen chloride	27.2	14.5	(27.2)
Isopropyl alcohol	1,470	2,538	(1,470)
Methanol	9	9	(9)
Methyl ethyl ketone	145	123.6	(145)
Methyl isobutyl ketone	27.2	27.2	(27.2)
Perchloroethylene	263	263	(363)
Toluene	454	506	(454)
Toluene-2,4-Diisocyanate	<9	<9	(<9)
Trichloroethane	36.3	36.3	(36.3)
Trichloroethylene	2,359	3,201	(2,359)
Xylene	235.9	235.9	(235.9)

Note: Parentheses indicate a net reduction in emissions.
Source: KC ASI 1995a.

of the time, neutral conditions approximately 61 percent of the time, and stable conditions approximately 24 percent of the time, on an annual basis.

Annual Mean Wind Speeds and Direction Frequencies. The Kansas City National Weather Service meteorological data for annual mean wind speed and direction for 1991 is presented in figure B.3.4–1 as a wind rose. As shown in this figure, the maximum wind direction frequency is from the south with a secondary maximum from the southsouthwest. The mean wind speed from the south is 6.1 m/s (13.6 mph); while the maximum mean wind speed is 6.3 m/s (14.1 mph) from the southsouthwest.

B.3.5 Pantex Plant

This section provides information on climatology and meteorology, atmospheric dispersion characteristics, and annual mean wind speed and direction frequencies (figure B.3.5–1) at Pantex. Table B.3.5-1 presents emission source inventories for criteria and toxic/hazardous pollutants at Pantex. This information supports data presented in the environmental impacts section for air quality.

Climatology and Meteorology. Figure B.3.5-1 shows annual mean wind speeds and wind direction frequencies for 1991 measured at the 6.6-m (21.6-ft) level of the Amarillo National Weather Service

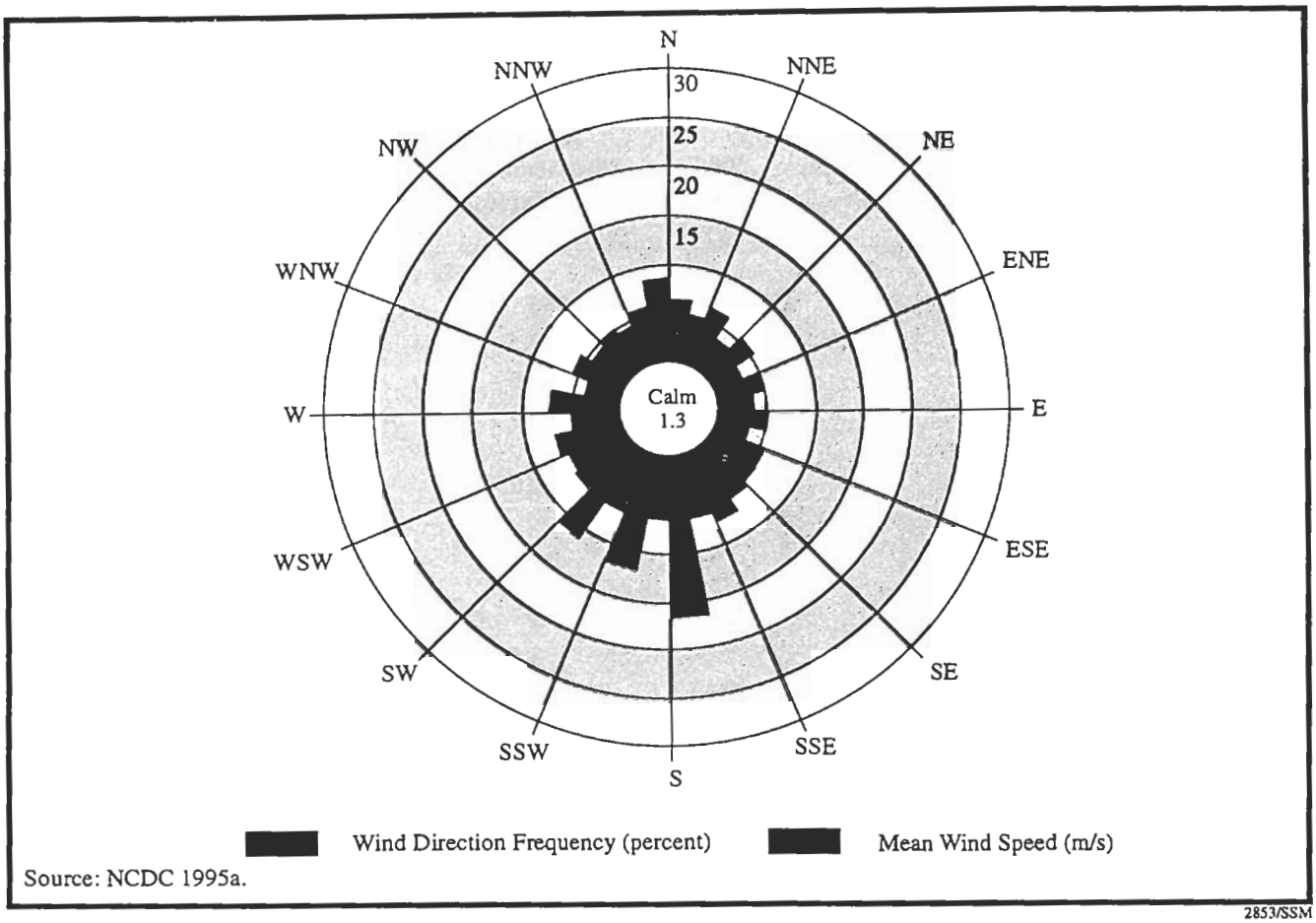


FIGURE B.3.5–1.—*Wind Distribution at Pantex Plant, 1991.*

station. Prevailing wind directions are from the south to southwest. The average annual wind speed measured is 6 m/s (13.5 mph).

The average annual temperature at Pantex is 13.8 °C (56.9 °F); average daily temperatures vary from a daily mean minimum of -5.7 °C (21.8 °F) in January to a daily mean maximum of 32.8 °C (91.1 °F) in July and August. Relative humidity readings taken four times per day range from 31 percent in April to 80 percent in September (NOAA 1994c:3).

The average annual precipitation at Pantex is 49.7 cm (19.56 in). Most of the annual precipitation falls during the months of April through October and usually occurs from thunderstorm activity and the intrusion of warm, moist tropical air form the Gulf of Mexico. Snowfall averages nearly 43 cm (16.9 in). Snowfall can occur from October through April. The maximum 24-hour rainfall with a 100-year recurrence interval is approximately 16.5 cm (6.5 in). On average, the area can expect thunderstorms about 50 days per year, hail 4 days per year, and freezing rain 8 days per year (NOAA 1994c:3). During the 30-year period between 1954 and 1983, a total of 108 tornadoes were reported within a 1-degree latitude and longitude square area which includes Pantex. On average, less than four tornadoes per year occur in an area of 10,096 km^2 (3,898 mi^2) surrounding Pantex. The estimated probability of a tornado striking a point at Pantex is 2.3×10^{-4} per year (NRC 1986a:32).

Emission Rates. Table B.3.5–1 presents the emission rates for criteria and toxic/hazardous pollutants at Pantex. These emission rates were used as input into the Industrial Source Complex Short-Term model, version 2, to estimate pollutant concentrations.

Atmospheric Dispersion Characteristics. Data collected at the Amarillo National Weather Service station for 1991 indicate that unstable conditions occur approximately 14 percent of the time, neutral conditions approximately 64 percent of the time, and stable conditions approximately 22 percent of the time, on an annual basis.

TABLE B.3.5–1.—*Emission Rates for Proposed Management Alternatives at Pantex Plant* [Page 1 of 2]

Pollutant	2005 No Action (kg/yr)	Downsize Assembly/ Disassembly and High Explosives (kg/yr)	Downsize Assembly/ Disassembly (kg/yr)	Phaseout of Assembly/ Disassembly and High Explosives (kg/yr)
Criteria Pollutant				
Carbon monoxide	22,493	5,856	5,443	(22,493)
Hydrogen fluoride	1,176.06	4.5	a	(1,176.06)
Lead	185	a	a	(185)
Nitrogen dioxide	54,056	22,879	21,319	(54,056)
Particulate matter	8,439	884	816	(8,439)
Sulfur dioxide	0.1	0.03	0.02	(0.1)
Hazardous and Other Toxic Compounds				
Acetonitrile	a	2.8	2.3	a
Alcohols	1,184	a	a	(1,184)
Aldehydes	a	6.5	4.5	a
Ammonia	<0.45	<0.45	<0.45	(<0.45)
Benzene	91.38	3.0	a	(91.38)
Carbon disulfide	27.05	a	a	(27.05)
Carbon tetrachloride	15.59	a	a	(15.59)
Chlorobenzene	1.79	a	a	(1.79)
1,1,1-Chloroethane	22.74	a	a	(22.74)
Chromium	2.14	a	a	(2.14)
Cyclohexane	a	2.2	0.45	a
Cresol	0.05	a	a	(0.05)
Cresylic acid	0.05	a	a	(0.05)
Dibensofuran	0.07	a	a	(0.07)
Dibutyl phthalate	a	5.4	5.4	a
Ester glycol ethers	0.86	a	a	(0.86)
Ethyl benzene	1.51	a	a	(1.51)
Ethylene dichloride	1.33	a	a	(1.33)
Formaldehyde	57.89	a	a	(57.89)
Hydrogen chloride	1,106.11	27.7	24.5	(1,106.11)
Hydrogen sulfide	0	21.3	21.3	(0)
Ketones	0.28	a	a	(0.28)
Mercury	<0.45	<0.45	<0.45	(<0.45)
Methanol	1,095.57	11.8	9.1	(1,095.57)
Methyl ethyl ketone	7,067.62	666.8	317.5	(7,067.62)
Methyl isobutyl ketone	0.62	a	a	(0.62)
Methylene chloride	182.07	a	a	(182.07)
Naphthalene	0.41	a	a	(0.41)
Nickel	0.16	a	a	(0.16)
Nitrobenzene	0.05	a	a	(0.05)
2-Nitropropane	1.71	a	a	(1.71)
Phenol	2.23	a	a	(2.23)
Propylglycol methyl ether	a	7.3	7.3	a

TABLE B.3.5–1.—*Emission Rates for Proposed Management Alternatives at Pantex Plant* [Page 2 of 2]

Pollutant	2005 No Action (kg/yr)	Downsize Assembly/ Disassembly and High Explosives (kg/yr)	Downsize Assembly/ Disassembly (kg/yr)	Phaseout of Assembly/ Disassembly and High Explosives (kg/yr)
Hazardous and Other Toxic Compounds (Continued)				
Tetrachloroethylene	6.44	[a]	[a]	(6.44)
Toluene	465.29	14.0	4.5	(465.29)
1,1,1-Trichloroethane	[a]	45.0	44.5	[a]
1,1,2-Trichloroethane	3.78	[a]	[a]	(3.78)
Trichloroethene	1.56	[a]	[a]	(1.56)
Trichloroethylene	19.50	5.0	4.5	(19.50)
Triethylamine	0	[a]	[a]	(0)
Xylene	222.15	166.5	158.8	(222.15)

[a] No sources indicated.

Note: Parentheses indicate a net reduction in emissions.

Source: PX 1996e:1, PX DOE 1996b; PX MH 1995a; PX MH 1995b.

Annual Mean Wind Speeds and Direction Frequencies. The Amarillo meteorological data for annual mean wind speed and direction for 1991 are presented in figure B.3.5–1 as a wind rose. As shown in this figure, the maximum wind direction frequency is from the south with a secondary maximum from the south-southwest. The mean wind speed from the south is 6.3 m/s (14.1 mph); from the south-southwest is 6.3 m/s (14.1 mph); while the maximum mean wind speed is 6.6 m/s (14.8 mph) from the west.

B.3.6 Los Alamos National Laboratory

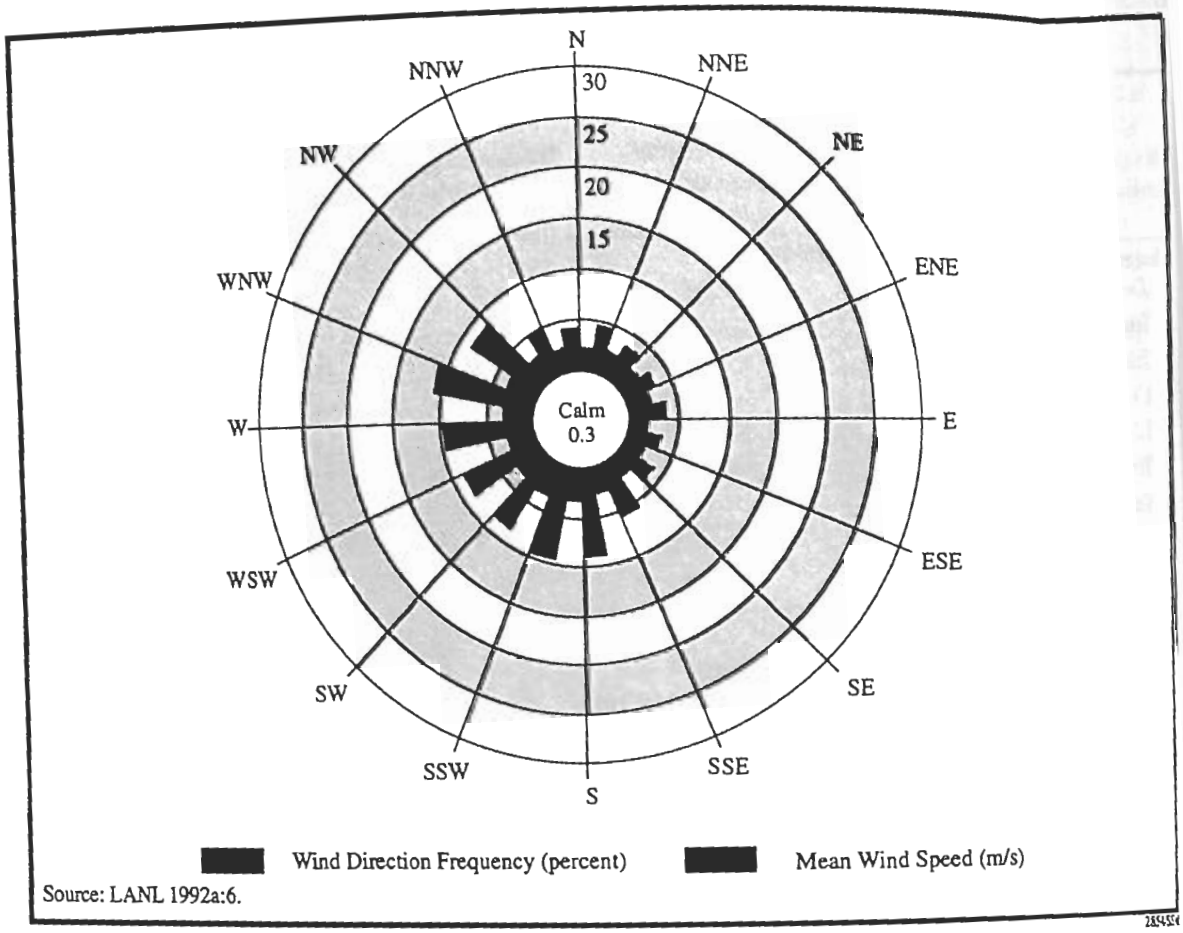
This section provides information on climatology and meteorology, modeling assumptions, atmospheric dispersion characteristics, and annual mean wind speed and direction frequencies (figure B.3.6–1) at LANL. Table B.3.6–1 presents emission source inventories for criteria and toxic/hazardous pollutants at LANL. This information supports data presented in the environmental impacts section for air quality.

Climatology and Meteorology. Figure B.3.6–1 shows annual mean wind speed and wind direction frequencies for 1991 measured at the 11.5-m (37-ft) level of the Technical Area (TA)-6 meteorological tower. Prevailing wind directions are from the south through northwest. The average annual wind speed measured is 2.8 m/s (6.3 mph) (LANL 1995s:II-11).

The average annual temperature at LANL is 8.8 °C (47.8 °F). In July, the average daily high temperature is 27.2 °C (81 °F), and the average nighttime low temperature is 12.8 °C (55 °F). The highest recorded temperature is 35 °C (95 °F). The average daily January high is 4.4 °C (40 °F), and the average nighttime low is -8.3 °C (17 °F). The lowest recorded temperature is -27.8 °C (-18 °F). The average monthly values of the dew point temperature range from -9.4 °C (15.0 °F) in January to 8.9 °C (48 °F) in August, when moist subtropical air invades the region. Fog is rare in Los Alamos, occurring on fewer than 5 days per year (LANL 1995s:II-11).

The average annual precipitation at LANL is 47.6 cm (18.7 in). Most of the annual precipitation falls during the months of July and August and usually occurs from convective storms. Snowfall averages nearly 150 cm (59 in). The maximum 24-hour rainfall is approximately 8.8 cm (3.5 in) (LANL 1995s:II-11).

The average annual temperature at the National Weather Service station at Albuquerque, NM, is 13.4 °C (56.2 °F); temperatures vary from an average



Source: LANL 1992a:6.

FIGURE B.3.6–1.—*Wind Distribution at Los Alamos National Laboratory, 1991.*

daily minimum of -5.7 °C (21.7 °F) in January to an average daily maximum of 33.6 °C (92.5 °F) in July. Relative humidity readings taken four times per day range from 19 percent in April and May to 71 percent in January (NOAA 1994c:3).

The average annual precipitation is 22.6 cm (8.88 in). The maximum monthly precipitation recorded was 8.5 cm (3.33 in) in July 1968, while the maximum rainfall in a 24-hour period observed was recorded in September 1955 at 4.9 cm (1.92 in). The average annual snowfall is 28.2 cm (11.1 in); all measurements are from the Albuquerque National Weather Service station (NOAA 1994c:3). The average number of thunderstorm days per year is 58, with most occurring during the summer. The estimated probability of a tornado striking a point at LANL is 2×10^{-5} per year (NRC 1986a:32). Historically, no tornadoes have been reported to have touched down in Los Alamos County (LANL 1993b:II-9).

Emission Rates. Table B.3.6–1 presents the emission rates for criteria and toxic/hazardous pollutants at LANL. These emission rates were used as input into the Industrial Source Complex Short-Term model, version 2, to estimate pollutant concentrations.

Modeling Assumptions. Additional model inputs used to estimate maximum pollutant concentrations at or beyond the LANL site boundary include the following: criteria pollutant emissions were modeled from actual stack locations using actual stack heights, stack diameter, exit velocity, and exit temperatures taken from operating permits; toxic/hazardous pollutant emissions were modeled from a centrally located stack in the LANL facility at a height of 10 m (32.8 ft), stack diameter of 0.3 m (1 ft), exit velocity of 0.03 m/s (0.1 ft/s), and exit temperature equal to ambient temperature.

TABLE B.3.6–1.—*Emission Rates for Proposed Stewardship and Management Alternatives at Los Alamos National Laboratory* [Page 1 of 2]

Pollutant	2005 No Action (kg/yr)	Pit Fabrication (kg/yr)	Secondary and Case Fabrication (kg/yr)	High Explosives Fabrication (kg/yr)	Nonnuclear Fabrication (kg/yr)	Atlas Facility (kg/yr)	National Ignition Facility (kg/yr)
Criteria Pollutant							
Carbon monoxide	21,583	a	4,500	4,536	a	a	460
Lead	26	a	100	a	a	<0.1	a
Nitrogen dioxide	55,314	a	117,000	22,680	a	a	1,910
Particulate matter	2,983	a	300	227	a	a	180
Sulfur dioxide	704.6	a	48,000	a	a	a	30
Total suspended particulates[b]	2,983	a	300	227	a	a	180
Hazardous and Other Toxic Compounds							
Acetic acid	537	a	a	a	a	a	a
Ammonia	799	a	a	454	a	a	a
2-Butoxyethanol	123	a	a	a	a	a	a
Chlorine	13	340	a	a	a	a	a
Chloroform	533	a	a	a	a	a	a
Ethyl acetate	89	a	a	a	a	a	a
Ethylene glycol	72	a	a	a	a	a	a
Formaldehyde	49	a	a	a	a	a	a
Heavy metals	114	a	a	a	a	a	a
Heptane (n-heptane)	1,849	a	a	a	a	a	a
Hexane (n-hexane)	77	a	a	a	a	a	a
Hydrogen chloride	638	11	a	113	a	a	a
Hydrogen fluoride (as F)	242	a	a	45.4	a	a	a
Isopropyl alcohol	539	a	a	a	a	<0.1	a
Kerosene	260	a	a	a	a	a	a
Methyl alcohol	589	a	a	a	a	a	a
Methyl ethyl ketone	1,864	a	a	22.7	a	a	a
Methylene chloride	1,104	a	a	a	a	a	a
Nickel	55	a	a	a	a	a	a
Nitric acid	661	a	a	a	a	a	a
Nitrogen oxide	428	a	a	a	a	a	a
Nonmethane hydrocarbons	2,893	a	a	a	a	a	a
Propane sultone	205	a	a	a	a	a	a
Stoddard solvent	264	a	a	a	a	a	a
Toluene	2,483	a	a	22.7	a	a	a
1, 1, 2-Trichloroethane	927	a	a	a	a	<0.1	a

TABLE B.3.6–1.—*Emission Rates for Proposed Stewardship and Management Alternatives at Los Alamos National Laboratory* [Page 2 of 2]

Pollutant	2005 No Action (kg/yr)	Pit Fabrication (kg/yr)	Secondary and Case Fabrication (kg/yr)	High Explosives Fabrication (kg/yr)	Nonnuclear Fabrication (kg/yr)	Atlas Facility (kg/yr)	National Ignition Facility (kg/yr)
Hazardous and Other Toxic Compounds (Continued)							
Trichloroethylene	210	a	a	a	a	<0.1	a
Tungsten (as W) (insoluble)	109	a	a	a	a	a	a
VM&P naptha	613	a	a	a	a	a	a
Welding fumes	511	a	a	a	a	a	a
Xylene (o-, m-, p-isomers)	1,762	a	a	a	a	a	a

[a] No sources indicated.

[b] It is assumed that PM^{10} emissions are total suspended particulates emissions.

Source: LANL 1995c; LANL 1995d; LANL 1995e; LANL 1995g; appendix I; appendix K.

Atmospheric Dispersion Characteristics. Data collected at the TA-6 meteorological tower for 1991 indicate that unstable conditions occur approximately 45 percent of the time, neutral conditions approximately 21 percent of the time, and stable conditions approximately 34 percent of the time, on an annual basis.

Annual Mean Wind Speeds and Direction Frequencies. The TA-6 meteorological data for wind speed and direction for 1991 is presented in figure B.3.6–1 as a wind rose. As shown in this figure, the maximum wind direction frequency is from the west-northwest with a secondary maximum from the west. The mean wind speed from the west-northwest is 3.2 m/s (7.2 mph), which is also the maximum mean wind speed. The mean wind speed from the west is 3 m/s (6.7 mph).

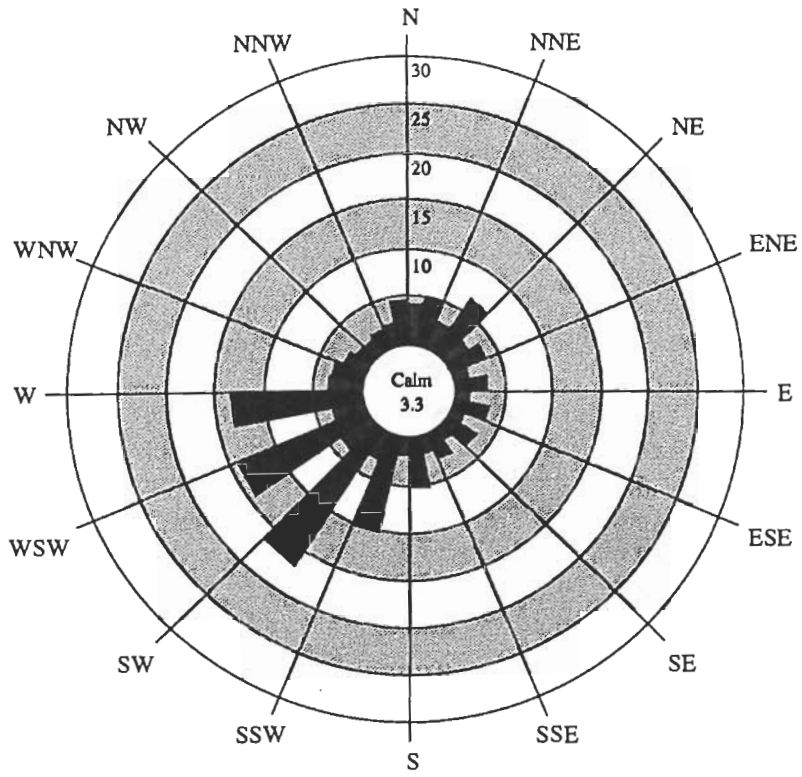
B.3.7 Lawrence Livermore National Laboratory

This section provides information on climatology and meteorology, modeling assumptions, atmospheric dispersion characteristics, and annual mean wind speeds and direction frequencies (figures B.3.7–1 and B.3.7–2) at the Livermore Site and Site 300. Table B.3.7–1 presents emission source inventories for criteria and toxic/hazardous pollutants at the Livermore Site and Site 300. This information supports data presented in the environmental impacts section for air quality.

Climatology and Meteorology. Figures B.3.7–1 and B.3.7–2 show annual mean wind speed and wind direction frequencies for 1991 measured at the 10-m (32.8-ft) level of the Livermore Site and Site 300 meteorological monitoring sites. Prevailing wind directions at the Livermore Site are from the south-southwest through west while at Site 300 the prevailing wind direction is from the west-southwest. The average annual wind speed measured at the Livermore Site is 2.5 m/s (5.7 mph) while at Site 300 the average annual wind speed is 5.9 m/s (13.1 mph).

The annual mean temperature at the Livermore Site is 12.5 °C (54.5 °F); temperatures range from a minimum of 0 °C (32 °F) in the winter to 38 °C (100.4 °F) in summer (LLNL 1993b:1-2).

The average annual precipitation at the Stockton, CA National Weather Service station is 35.4 cm (13.95 in). Most of the annual precipitation falls from October through April. Snowfall is rare in the Livermore Site area. The maximum 24-hour rainfall is approximately 7.65 cm (3.01 in). On the average, the area can expect thunderstorms about 3.1 days per year (NOAA 1994d:3).



Source: LLNL 1995b.

2855/SSM

FIGURE B.3.7–1.—*Wind Distribution at the Livermore Site, 1991.*

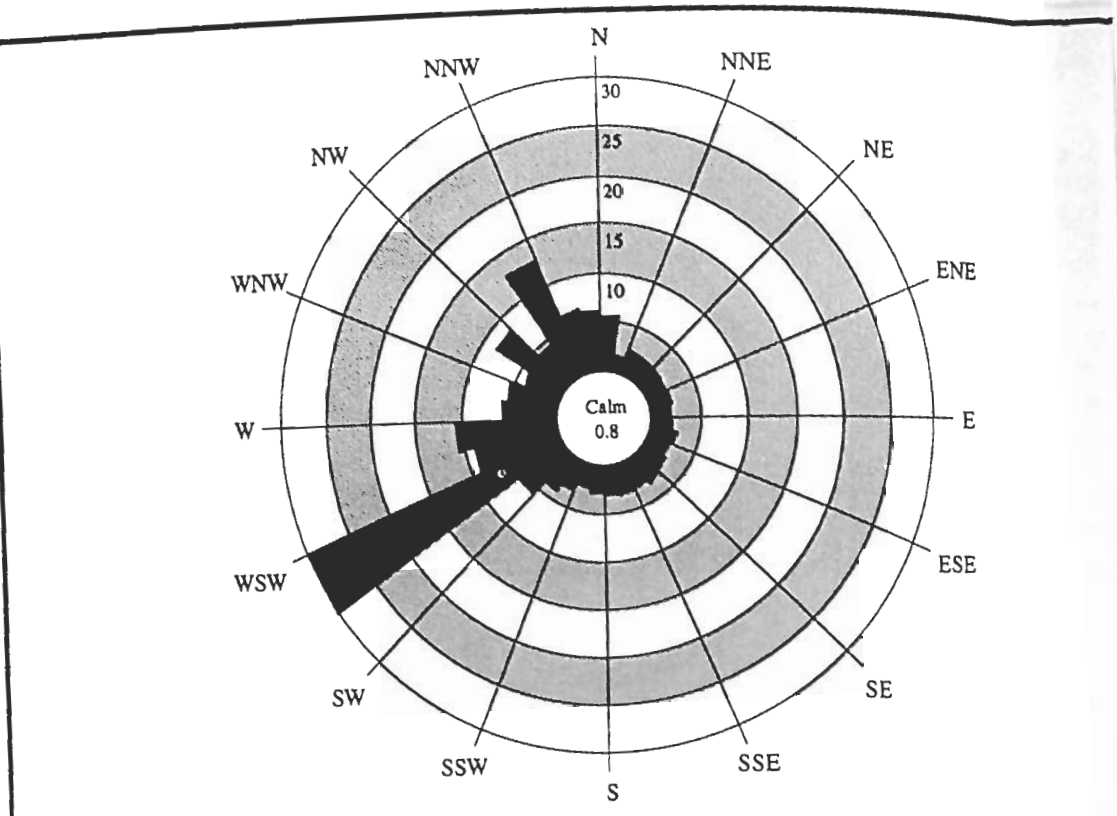
The climate at Site 300, while generally similar to the Livermore Site, is modified by higher elevation and more pronounced relief. The temperature range is somewhat more extreme than the Livermore Site, and topography significantly influences surface wind patterns (LLNL 1993b:1-3).

Emission Rates. Table B.3.7–1 presents the emission rates for criteria and toxic/hazardous pollutants at the Livermore Site and Site 300. These emission rates were used as input into the Industrial Source Complex Short-Term model, version 2, to estimate pollutant concentrations.

Modeling Assumptions. Additional model input used to estimate maximum pollutant concentrations at or beyond the site boundary include the following: criteria pollutant emissions were modeled from actual stack locations using actual stack heights, stack diameter, exit velocity, and exit temperature, taken from operating permits; toxic/hazardous pollutant emissions were modeled from a centrally located stack in the facility at a height of 10 m (32.8 ft), stack diameter of 0.3 m (1.0 ft), exit velocity of 0.03 m/s (0.1 ft/s), and exit temperature equal to ambient temperature.

Atmospheric Dispersion Characteristics. Data collected at the Livermore Site and Site 300 for 1991 indicate that unstable conditions occur approximately 32/37 percent of the time, neutral conditions approximately 35/34 percent of the time, and stable conditions approximately 33/29 percent of the time, on an annual basis.

Annual Mean Wind Speeds and Direction Frequencies. The 1991 meteorological data for wind speed and direction for the Livermore Site and Site 300 are presented in figures B.3.7–1 and B.3.7–2 as wind roses. As shown in the figures, the maximum



Source: LLNL 1995b.

FIGURE B.3.7–2.—*Wind Distribution at Site 300, 1991.*

TABLE B.3.7–1.—*Emission Rates for Proposed Stewardship and Management Alternatives at the Livermore Site and Site 300* [Page 1 of 2]

Pollutant	2005 No Action		Secondary and Case Fabrication (kg/yr)	High Explosives Fabrication (kg/yr)	Nonnuclear Fabrication (kg/yr)	Contained Firing Facility (kg/yr)[a]	National Ignition Facility (kg/yr)
	Livermore Site (kg/yr)	Site 300 (kg/yr)					
Criteria Pollutant							
Beryllium	0.002	0.279	c	c	b	-	c
Carbon monoxide	5,629	1,854	1000	113.4	b	-	430
Lead	0.0068	0.059	c	c	b	-	c
Nitrogen dioxide	32,450	8,576	1,900	249.5	b	-	1,790
Particulate matter[d]	4,636	993	100	22.7	b	-	160
Sulfur dioxide	430	99	20	13.6	b	-	30
Total suspended particulates	4,636	993	3,200	22.7	b	-	160

TABLE B.3.7–1.—*Emission Rates for Proposed Stewardship and Management Alternatives at the Livermore Site and Site 300* [Page 2 of 2]

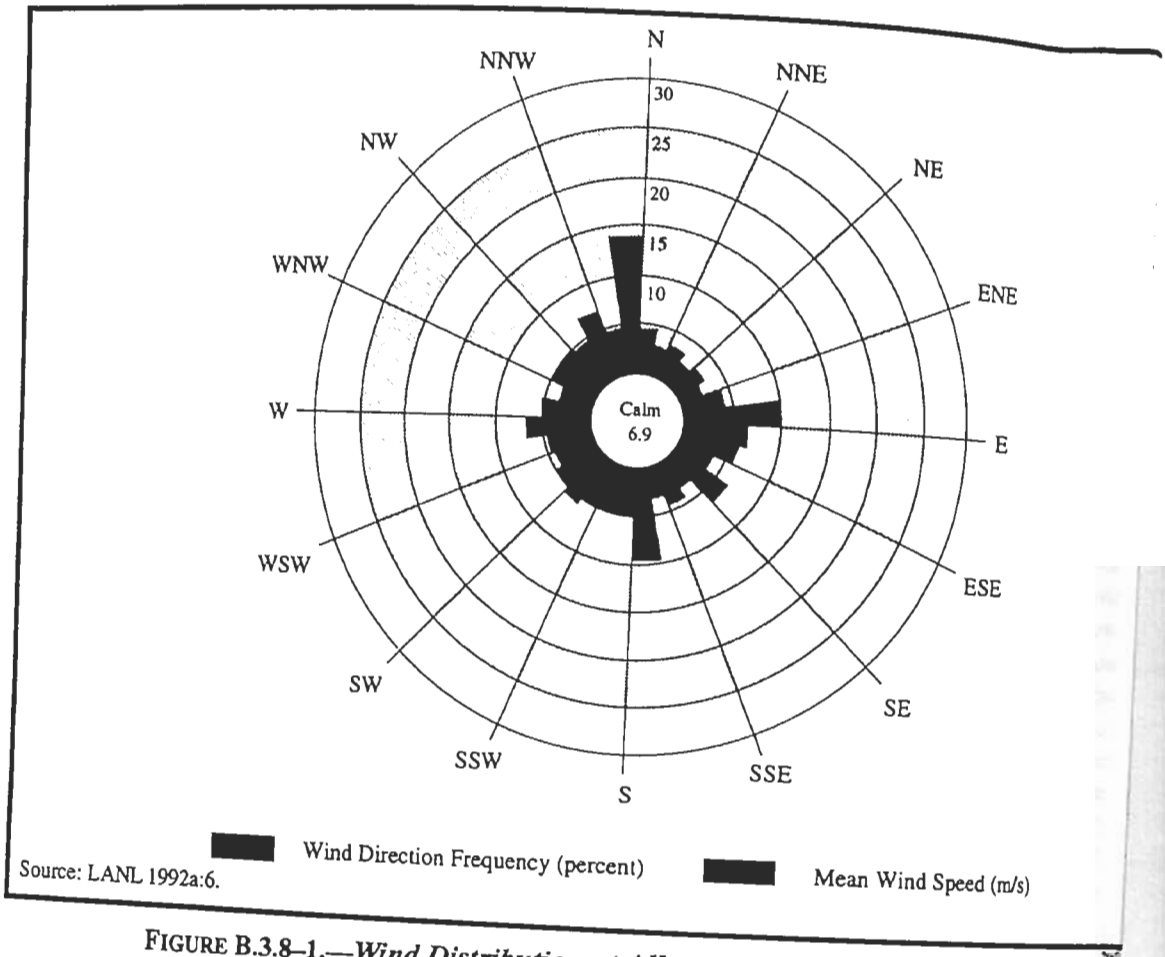
Pollutant	2005 No Action: Livermore Site (kg/yr)	2005 No Action: Site 300 (kg/yr)	Secondary and Case Fabrication (kg/yr)	High Explosives Fabrication (kg/yr)	Nonnuclear Fabrication (kg/yr)	Contained Firing Facility (kg/yr)[a]	National Ignition Facility (kg/yr)
Hazardous and Other Toxic Compounds							
Acetone	818.7	45.4	c	c	b	-	c
Benzene	100.2	0.082	c	c	b	-	c
2-Butoxyethanol	153.8	c	c	c	b	-	c
Carbon tetrachloride	204.6	c	c	c	b	-	c
Chlorine	c	c	50	c	b	-	c
Chlorofluorocarbons	8,705.3	163.7	c	c	b	-	c
Chloroform	188.7	0.054	c	c	b	-	c
Ethanol	322.1	<0.45	c	c	b	-	c
Formaldehyde	53.52	1.91	c	c	b	-	c
Gasoline	c	367.1	c	c	b	-	c
Glycol ethers (other)	2.99	53.1	c	c	b	-	c
Hexane	59.4		c	c	b	-	c
Hydrogen chloride	64.4	60.2	1,600	45.4	b	-	c
Hydrogen fluoride	c	c	c	90.7	b	-	c
Hydrogen sulfide	c	c	c	c	b	-	c
Isopropyl alcohol	729.4	0.14	c	c	b	-	c
Methanol	949.37	c	4,500	c	b	-	c
Methyl ethyl ketone	338.4	0.27	c	6.8	b	-	c
Methylene chloride	133.81	1.72	c	c	b	-	c
Nephthalene	73.48	c	c	c	b	-	c
Nitric acid	c	c	2,300	c	b	-	c
Styrene	1,270.1	c	c	c	b	-	c
Sulfuric acid	c	c	600	c	b	-	c
Tetrohydrofuran	61.23	c	c	c	b	-	c
Toluene	384.65	18.44	c	c	b	-	c
1, 1, 1-Trichloroethane	981.6	c	c	c	b	-	c
Trichloroethylene	175.99	3.63	c	c	b	-	c
Xylene	222.26	4.99	c	2.7	b	-	c

[a] Contained Firing Facility air emissions are addressed in appendix J.
[b] No increase over No Action.
[c] No sources indicated.
[d] It is conservatively assumed that particulate matter emissions are total suspended particulates emissions.
Source: LLNL 1995e; LLNL 1995f; LLNL 1995i:5; LLNL 1995j; appendix I; appendix J.

wind direction frequency at the Livermore Site and Site 300 is from the southwest/west-southwest with a secondary maximum from the west-southwest/north-northwest. The mean wind speed from the southwest/west-southwest is 3.4/8.9 m/s (7.7/19.9 mph) and from the west-southwest/north-northwest is 3.0/6.3 m/s (6.7/14.1 mph).

B.3.8 Sandia National Laboratories

This section provides information on climatology and meteorology, modeling assumptions, atmospheric dispersion characteristics, and annual mean wind speeds and direction frequencies (figure B.3.8–1) at SNL. Table B.3.8–1 presents emission source inven-



Source: LANL 1992a:6.

FIGURE B.3.8–1.—*Wind Distribution at Albuquerque, New Mexico, 1991.*

tories for criteria and toxic/hazardous pollutants at SNL. This information supports data presented in the environmental impacts section for air quality.

Climatology and Meteorology. Figure B.3.8–1 shows annual mean wind speeds and wind direction frequencies for 1991 measured at the 10-m (32.8-ft) level of the Albuquerque National Weather Service station. Prevailing wind directions are from the north. The average annual wind speed measured is 4 m/s (9 mph).

The average annual temperature at SNL is 13.4 °C (56.2 °F); average daily temperatures vary from a minimum of -5.7 °C (21.7 °F) in January to a maximum of 33.6 °C (92.5 °F) in July (NOAA 1994c:3).

The average annual precipitation at SNL is 22.6 cm (8.88 in). Most of the annual precipitation falls during the months of July through October and usually occurs from thunderstorm activity and the intrusion of warm, moist tropical air form the Gulf Mexico. Snowfall averages nearly 28.2 cm (11.1 in Snowfall has occurred from October through Apr The maximum 24-hour rainfall was 4.9 cm (1.92 occurring in September 1955. On the average, the area can expect thunderstorms about 41 days per ye (NOAA 1994c:3). The estimated probability of tornado striking a point at SNL is 2.0×10^{-5} per ye (NRC 1986a:32).

Emission Rates. Table B.3.8–1 presents the emission rates for criteria and toxic/hazardous pollutants SNL. These emission rates were used as input into the Industrial Source Complex Short-Term model, version 2, to estimate pollutant concentrations.

Modeling Assumptions. Additional model inputs used to estimate maximum pollutant concentrations or beyond the SNL site boundary include the follow-

TABLE B.3.8–1.—*Emission Rates for Proposed Stewardship and Management Alternatives at Sandia National Laboratories*

Pollutant	2005 No Action (kg/yr)	Nonnuclear Fabrication (kg/yr)	National Ignition Facility (kg/yr)
Criteria Pollutant			
Carbon monoxide	230[a]	[b]	520
Nitrogen dioxide	1,070[a]	[b]	2,150
Particulate matter	3,760[a]	[b]	200
Sulfur dioxide	70[a]	[b]	40
Total suspended particulates	[b]	[b]	[b]
Hazardous and Other Toxic Compounds			
Acetone	247	[b]	[b]
Benzene	1.1	[b]	[b]
Carbon tetrachloride	2.7	[b]	[b]
Hydrogen chloride	3,227	[b]	[b]
Isopropyl alcohol	106	[b]	[b]
Methanol	108	[b]	[b]
Methyl chloroform	703	[b]	[b]
Methylene chloride	40	[b]	[b]
Toluene	546	[b]	[b]
Trichloroethylene	103	[b]	[b]
Trichlorotrifluoroethane	151	[b]	[b]
Xylene	580	[b]	[b]

[a] Based on steam plant and stand-by steam plant emissions.
[b] No sources indicated.
Source: SNL 1991b:1; SNL 1995e; appendix I.

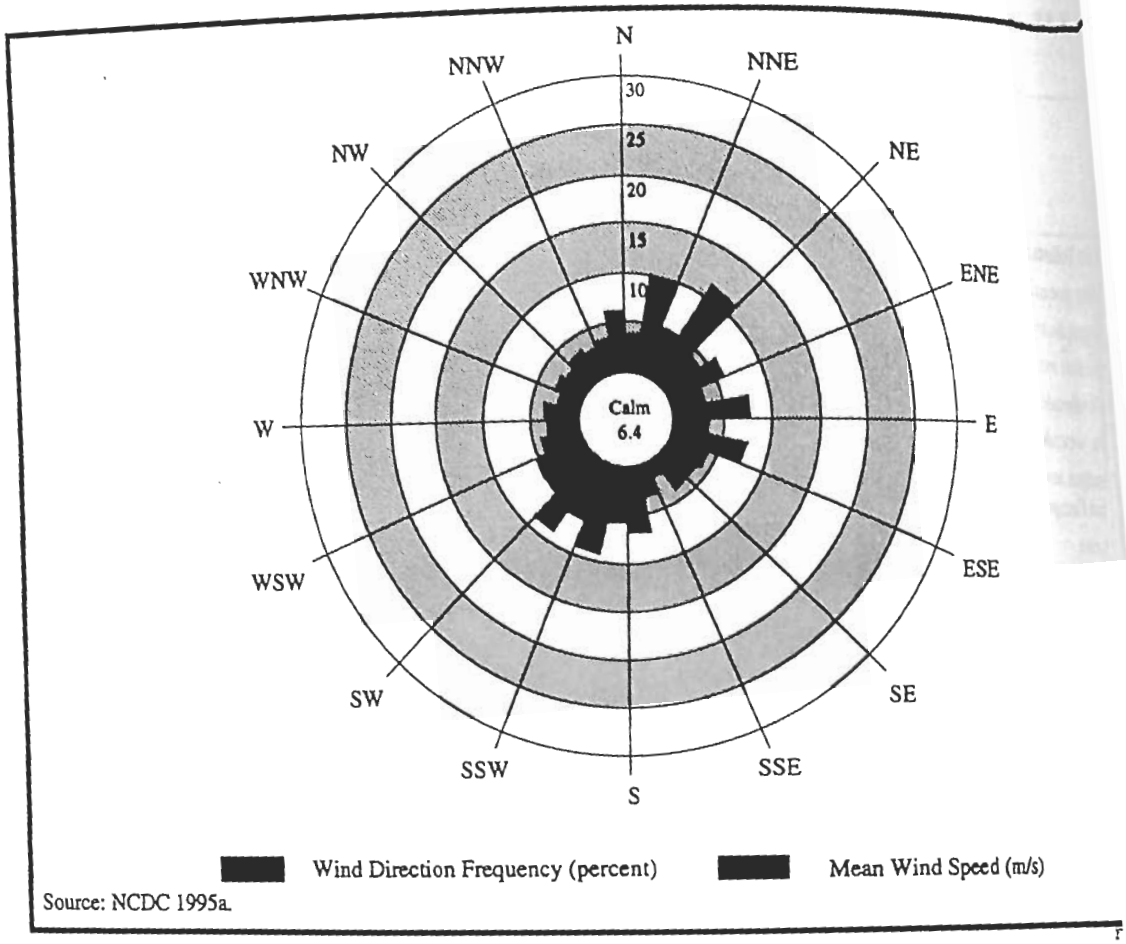
ing: criteria pollutant emissions were modeled from actual stack locations using actual stack heights, stack diameter, exit velocity, and exit temperature, taken from operating permits; toxic/hazardous pollutant emissions were modeled from a centrally located stack in the SNL facility at a height of 10 m (32.8 ft), stack diameter of 0.3 m (1 ft), exit velocity of 0.03 m/s (0.1 ft/s), and exit temperature equal to ambient temperature.

Atmospheric Dispersion Characteristics. Data collected at the Albuquerque National Weather Service station for 1991 indicate that unstable conditions occur approximately 28 percent of the time, neutral conditions approximately 38 percent of the time, and stable conditions approximately 34 percent of the time, on an annual basis.

Annual Mean Wind Speeds and Direction Frequencies. The Albuquerque National Weather Service meteorological data for annual mean wind speed and direction for 1991 are presented in figure B.3.8–1 as a wind rose. As shown in this figure, the maximum wind direction frequency is from the north with a secondary maximum from the east and south. The mean wind speed from the north is 4.1 m/s (9.2 mph); from the south is 4.8 m/s (10.7 mph); while the maximum mean wind speed is 6.4 m/s (14.3 mph) from the east.

B.3.9 Nevada Test Site

This section provides information on climatology and meteorology, modeling assumptions, atmospheric dispersion characteristics, and annual mean wind speeds and direction frequencies (figure B.3.9–1) at NTS. Table B.3.9–1 presents emission source inventories for criteria and toxic/hazardous pollutants at



Source: NCDC 1995a.

FIGURE B.3.9–1.—*Wind Distribution at Desert Rock, Nevada, 1991.*

NTS. This information supports data presented in the environmental impacts section for air quality.

Climatology and Meteorology. Figure B.3.9–1 shows annual mean wind speed and wind direction frequencies for 1991 measured at the 10-m (32.8-ft) level of the Desert Rock, Nevada National Weather Service station. Prevailing winds are southerly during summer and northerly during winter. The general downward slope in the terrain from north to south results in an intermediate scenario that is reflected in the characteristic diurnal wind reversal from southerly winds during the day to northerly winds at night. This north-to-south reversal is strongest in the summer and, on occasion, becomes intense enough to override the wind regime associated with large-scale pressure systems.

Average annual wind speeds and direction vary with location. At higher elevations on Pahute Mesa, the average annual wind speed is 4.7 m/s (10.5 mph).

The prevailing wind direction during winter is north-northeasterly, and during summer mostly southerly. In Yucca Flat the average annual speed is 3.1 m/s (6.9 mph). The prevailing direction during winter months is north-northeasterly and during summer months is south-southeasterly. At Mercury, NV, the average annual speed is 3.6 m/s (8.1 mph), with northwesterly prevailing winds during the winter months and southwesterly winds during the summer months (NVDOE 1994b:2-16).

Elevation influences temperatures on NTS. At elevation of 2,000 m (6,560 ft) above mean sea level on Pahute Mesa, the average daily maximum/minimum temperatures are 4.4/-2.2 °C (40/28 °F) in January and 26.7/16.7 °C (80/62 °F) in July. In Yucca Flat, 1,195 m (3,920 ft) above mean sea level, the average daily maximum/minimum temperatures are 10.6/-6.1 °C (51/21 °F) in January and 35.6/13.9 °C (96/57 °F) in July. The extreme temperatures

Mercury are 20.6/-11.1 °C (69/12 °F) in January and 42.8/15 °C (109/59 °F) in July (NT DOE 1993e:2-17,2-19).

The average annual temperature at the Las Vegas National Weather Service station is 19.5 °C (67.1 °F); average daily temperature varies from a minimum of 0.9 °C (33.6 °F) in January to a maximum of 41.1 °C (105.9 °F) in July. The average annual precipitation at the Las Vegas National Weather Service station is 10.5 cm (4.13 in) (NOAA 1994d:3). Annual precipitation in southern Nevada is very light and depends largely upon elevation. On NTS, the mesas receive an average annual precipitation of 23 cm (9 in), which includes winter snow accumulations. The lower elevations receive approximately 15 cm (6 in) of precipitation annually, with occasional snow accumulations lasting only a few days (NT DOE 1993e:2-17,2-19).

Precipitation usually falls in isolated showers with large variations in precipitation amounts within a shower area. Summer precipitation occurs mainly in July and August when intense heating of the ground below moist air masses triggers thunderstorm development. On rare occasions, a tropical storm will move northeastward from the west coast of Mexico, bringing heavy precipitation during September and/or October.

Wind speeds in excess of 27 m/s (60 mph), with gusts up to 48 m/s (107 mph), may be expected to occur on a 100-year return period. Other than temperature extremes, severe weather in the region includes occasional thunderstorms, lightning, tornadoes, and sandstorms. Severe thunderstorms may produce high precipitation with durations of approximately 1 hour, and may create a potential for flash flooding (NT DOE 1983a:26). Tornadoes have been observed in the region but are infrequent. The estimated probability of a tornado striking a point at NTS is 3.0×10^{-7} per year (NRC 1986a:32).

Emission Rates. Table B.3.9–1 presents the emission rates for criteria and toxic/hazardous pollutants at NTS. These emission rates were used as input into the Industrial Source Complex Short-Term model, version 2, to estimate pollutant concentrations.

Modeling Assumptions. Additional model input used to estimate maximum pollutant concentrations at or beyond the NTS site boundary include the following: criteria pollutant emissions were modeled from actual stack locations using actual stack heights, stack diameter, exit velocity, and exit temperature, taken from operating permits; toxic/hazardous pollutant emissions were modeled from a centrally located stack in the NTS facility at a height of 10 m (32.8 ft), stack diameter of 0.3 m (1 ft), exit velocity

TABLE B.3.9–1.—*Emission Rates for Proposed Stewardship and Management Alternatives at Nevada Test Site*

Pollutant	2005 No Action[a] (kg/yr)	Assembly/ Disassembly (kg/yr)	National Ignition Facility (kg/yr)
Criteria Pollutant			
Carbon monoxide	[b]	454	370
Hydrogen sulfide	[b]	[b]	[b]
Nitrogen dioxide	[b]	6,350	2,010
Particulate matter	86,820	136	80
Sulfur dioxide	71,125	6,804	4
Total suspended particulates	[c]	[c]	[c]
Hazardous and Other Toxic Compounds	[b]	[b]	[b]

[a] Based on permitted sources.
[b] No sources indicated.
[c] No data available.
Source: NT DOE 1995b; NV DCNR 1992a; appendix I.

of 0.03 m/s (0.1 ft/s), and exit temperature equal to ambient temperature.

Atmospheric Dispersion Characteristics. Data collected at the NTS meteorological monitoring station for 1991 indicate that unstable conditions occur approximately 26 percent of the time, neutral conditions approximately 37 percent of the time, and stable conditions approximately 37 percent of the time, on an annual basis.

Annual Mean Wind Speed and Frequencies. The NTS meteorological annual mean wind speed and direction for presented in figure B.3.9–1 as a wind rose. in this figure, the maximum wind direction is from the northeast with a secondary from the north-northeast. The mean wind the northeast is 4.2 m/s (9.4 mph) from northeast is 4.7 m/s (10.5 mph); while the mean wind speed is 6.3 m/s (14.1 mph) south-southwest.

APPENDIX C

Appendix C

APPENDIX C: THREATENED, ENDANGERED, AND SPECIAL STATUS SPECIES

This appendix contains tables C-1 through C-7 that present flora and fauna identified by the U.S. Fish and Wildlife Service (USFWS) and state governments as threatened, endangered, or other special status. Special status species include Federal candidate species and state classifications such as species of concern or species in need of management. The threatened, endangered, and special status lists include all such species which could potentially occur in a site area regardless of their residence status (i.e., breeding, year round, summer, winter, or migratory) or likelihood of being affected by project actions.

TABLE C–1.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found at or in the Vicinity of Oak Ridge Reservation* [Page 1 of 3]

Common Name	Scientific Name	Status[a]	
		Federal	State
Mammals			
Alleghany woodrat	*Neotoma magister*	NL	D
Eastern cougar[b]	*Felis concolor couguar*	E	E
Eastern small-footed bat	*Myotis leibii*	NL	D
Gray bat[b]	*Myotis grisescens*	E	E
Indiana bat[b]	*Myotis sodalis*	E	E
Rafinesque's big-eared bat	*Plecotus rafinesquii*	NL	D
River otter	*Lutra canadensis*	NL	T
Smoky shrew	*Sorex fumeus*	NL	D
Southeastern shrew	*Sorex longirostris*	NL	D
Birds			
American peregrine falcon[b]	*Falco peregrinus anatum*	E	E
Appalachian Bewick's wren	*Thryomanes bewickii altus*	NL	T
Arctic peregrine falcon	*Falco peregrinus tundrius*	E(S/A)	E
Bachman's sparrow	*Aimophila aestivalis*	NL	E
Bald eagle[b,c]	*Haliaeetus leucocephalus*	T	T
Barn owl[d]	*Tyto alba*	NL	D
Cooper's hawk[d,e]	*Accipiter cooperii*	NL	D
Grasshopper sparrow	*Ammodramus savannarum*	NL	D
Northern harrier	*Circus cyaneus*	NL	D
Osprey[d]	*Pandion haliaetus*	NL	T
Red-cockaded woodpecker	*Picoides borealis*	E	E
Sharp-shinned hawk[d,e]	*Accipiter striatus*	NL	D
Swainson's warbler	*Limnothlypis swainsonii*	NL	D
Reptiles			
Eastern slender glass lizard	*Ophisaurus attenuatus longicaudus*	NL	D
Northern pine snake	*Pituophis melanoleucus melanoleucus*	NL	T
Amphibians			
Hellbender[d,e]	*Cryptobranchus alleganiensis*	NL	D
Tennessee cave salamander[f]	*Gyrinophilus palleucus*	NL	T

TABLE C–1.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found at or in the Vicinity of Oak Ridge Reservation* [Page 2 of 3]

Common Name	Scientific Name	Status[a]	
		Federal	State
Fish			
Alabama shad	*Alosa alabamae*	NL	D
Amber darter[b]	*Percina antesella*	E	E
Blue sucker	*Cycleptus elongatus*	NL	T
Flame chub	*Hemitremia flammea*	NL	D
Frecklebelly madtom	*Noturus munitus*	NL	T
Highfin carpsucker	*Carpiodes velifer*	NL	D
Spotfin chub[b]	*Cyprinella monacha*	T	E
Tennessee dace[d,e]	*Phoxinus tennesseensis*	NL	D
Yellowfin madtom[b]	*Noturus flavipinnis*	T	E
Invertebrates			
Alabama lampmussel[b]	*Lampsilis virescens*	E	E
Appalachian monkeyface pearlymussel[b]	*Quadrula sparsa*	E	E
Birdwing pearlymussel[b]	*Conradilla caelata*	E	E
Cumberland bean pearlymussel[b]	*Villosa trabalis*	E	E
Cumberland monkeyface pearlymussel[b]	*Quadrula intermedia*	E	E
Dromedary pearlymussel[b]	*Dromus dromas*	E	E
Fine-rayed pigtoe[b]	*Fusconaia cuneolus*	E	E
Green-blossom pearlymussel[b]	*Epioblasma torulosa gubernaculum*	E	E
Orange-footed pearlymussel[b]	*Plethobasus cooperianus*	E	E
Painted snake coiled forest snail	*Anguispira picta*	T	E
Pale lilliput pearlymussel[b]	*Toxolasma cylindrellus*	E	E
Pink mucket pearlymussel[b]	*Lampsilis abrupta*	E	E
Rough pigtoe[b]	*Pleurobema plenum*	E	E
Shiny pigtoe[b]	*Fusconaia cor*	E	E
Tan riffle shell[b]	*Epioblasma walkeri*	E	E
Tubercled-blossom pearlymussel[b]	*Epioblasma torulosa torulosa*	E	E
Turgid-blossom pearlymussel[b]	*Epioblasma turgidula*	E	E
White wartyback pearlymussel[b]	*Plethobasus cicatricosus*	E	E
Yellow-blossom pearlymussel[b]	*Epioblasma florentina florentina*	E	E
Plants			
American barberry	*Berberis canadensis*	NL	S
American ginseng[d,e]	*Panax quinquefolius*	NL	T
Appalachian bugbane[d]	*Cimicifuga rubifolia*	NL	T
Auriculate false-foxglove	*Tomanthera auriculata*	NL	E
Branching whitlowgrass	*Draba ramosissima*	NL	S
Butternut[d]	*Juglans cinerea*	NL	T
Canada (wild yellow) lily[d,e]	*Lilium canadense*	NL	T
Carey's saxifrage[d]	*Saxifraga careyana*	NL	S
Fen orchid[d,e]	*Liparis loeselii*	NL	E
Golden seal[d,e]	*Hydrastis canadensis*	NL	T
Gravid sedge[d,e]	*Carex gravida*	NL	S

TABLE C–1.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status S That May Be Found at or in the Vicinity of Oak Ridge Reservation* [Page 3 of 3]

Common Name	Scientific Name	Status[a]	
		Federal	Stat
Plants (Continued)			
Heartleaf meehania	*Meehania cordata*	NL	T
Heller's catfoot	*Gnaphalium helleri*	NL	S
Lesser ladies' tresses[d]	*Spiranthes ovalis*	NL	S
Michigan lily[d,e]	*Lilium michiganense*	NL	T
Mountain honeysuckle	*Lonicera dioica*	NL	S
Mountain witch alder[d]	*Fothergilla major*	NL	T
Northern bush honeysuckle[d]	*Diervilla lonicera*	NL	T
Nuttall waterweed[d]	*Elodea nuttallii*	NL	S
Pink lady's-slipper[d,e]	*Cypripedium acaule*	NL	E
Prairie goldenrod	*Solidago ptarmicoides*	NL	E
Purple fringeless orchid[d,e]	*Platanthera peramoena*	NL	T
Slender blazing star	*Liatris cylindracea*	NL	E
Spreading false foxglove[d]	*Aureolaria patula*	NL	T
Swamp lousewort	*Pedicularis lanceolata*	NL	T
Tall larkspur[d]	*Delphinium exaltatum*	NL	E
Tennessee purple coneflower[b]	*Echinacea tennesseenis*	E	E
Tubercled rein-orchid[d,e]	*Platanthera flava var. herbiola*	NL	T
Virginia spiraea	*Spiraea virginiana*	T	E
Whorled mountainmint	*Pycnanthemum verticillatum*	NL	E-P

[a] Status codes: D - deemed in need of management; E - endangered; NL- not listed; P - possibly extirpated; S - species of sp concern; S/A - protected under the similarity of appearances provision of the *Endangered Species Act*; T - threatened.

[b] USFWS Recovery Plan exists for this species.

[c] Observed near Oak Ridge Reservation (ORR) on Melton Hill and Watts Bar Lakes.

[d] Recent record of species occurrence on ORR.

[e] Species known to occur on or near proposed project site.

[f] Species collected on ORR in 1964.

Source: 50 CFR 17.11; 50 CFR 17.12; DOE 1995w; OR DOE 1990a; OR FWS 1992b; OR NERP 1993a; ORNL 1981a; ORNL 1984b; ORNL 1988c; TN DEC 1995a; TN DEC 1995b; TN DEC 1995c; TN DEC 1995d; TN WRC 1991a; TN WRC 1991b.

TABLE C–2.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found at or in the Vicinity of Savannah River Site* [Page 1 of 2]

Common Name	Scientific Name	Status[a]	
		Federal	State
Mammals			
Meadow vole	*Microtus pennsylvanicus*	NL	SC
Rafinesque's big-eared bat[b]	*Plecotus rafinesquii*	NL	SE
Southern Appalachian eastern woodrat[b]	*Neotoma floridana haematoreia*	NL	SC
Spotted skunk[b]	*Spilogale putorius*	NL	SC
Star-nosed mole[b]	*Condylura cristata parva*	NL	SC
Swamp rabbit	*Sylvilagus aquaticus*	NL	SC
Birds			
American peregrine falcon[b,c]	*Falco peregrinus anatum*	E	SE
American swallow-tailed kite	*Elanoides forficatus*	NL	SE
Appalachian Bewick's wren[b]	*Thryomanes bewickii altus*	NL	ST
Arctic peregrine falcon[b]	*Falco peregrinus tundrius*	E (S/A)	ST
Bald eagle[b,c]	*Haliaeetus leucocephalus*	T	SE
Barn owl[b]	*Tyto alba*	NL	SC
Common ground dove[b]	*Columbina passerina*	NL	ST
Cooper's hawk[b]	*Accipiter cooperii*	NL	SC
Kirtland's warbler[b]	*Dendroica kirtlandii*	E	SE
Mississippi kite[b]	*Ictinia mississippiensis*	NL	SC
Red-cockaded woodpecker[b,c]	*Picoides borealis*	E	SE
Red-headed woodpecker[b]	*Melanerpes erythrocephalus*	NL	SC
Swainson's warbler[b]	*Limnothlypis swainsonii*	NL	SC
Wood stork[b,d]	*Mycteria americana*	E	SE
Reptiles			
American alligator[b]	*Alligator mississippiensis*	T (S/A)	NL
Carolina swamp snake[b]	*Seminatrix pygaea*	NL	SC
Eastern coral snake[b]	*Micrurus fulvius fulvius*	NL	SC
Green water snake[b]	*Nerodia cyclopion*	NL	SC
Spotted turtle[b]	*Clemmys guttata*	NL	SC
Amphibians			
Carolina crawfish frog[b]	*Rana areolata capito*	NL	SC
Eastern bird-voiced treefrog[b]	*Hyla avivoca ogechiensis*	NL	SC
Eastern tiger salamander[b,d]	*Ambystoma tigrinum tigrinum*	NL	SC
Northern cricket frog[b]	*Acris crepitans crepitans*	NL	SC
Pickerel frog[b,d]	*Rana palustris*	NL	SC
Upland chorus frog[b]	*Pseudacris triseriata feriarum*	NL	SC
Fish			
Shortnose sturgeon[b,c,d]	*Acipenser brevirostrum*	E	SE
Invertebrates			
Brother spike mussel	*Elliptio fraterna*	NL	SE

TABLE C–2.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found at or in the Vicinity of Savannah River Site* [Page 2 of 2]

Common Name	Scientific Name	Status[a]	
		Federal	State
Plants			
Beak-rush[b,d]	*Rhynchospora inundata*	NL	SC
Bog spice bush[b]	*Lindera subcoriacea*	NL	RC
Cypress stump sedge[b,d]	*Carex decomposita*	NL	SC
Durand's white oak[b]	*Quercus durandii*	NL	SC
Dwarf bladderwort[b]	*Utricularia olivacea*	NL	SC
Dwarf burhead[b]	*Echinodorus parvulus*	NL	SC
Elliott's croton[b]	*Croton elliottii*	NL	SC
Few-fruited sedge[b]	*Carex oligocarpa*	NL	SC
Florida bladderwort[b]	*Utricularia floridana*	NL	SC
Florida false loosestrife[b]	*Ludwigia spathulata*	NL	SC
Gaura[b]	*Gaura biennis*	NL	SC
Green-fringed orchid[b,d]	*Platanthera lacera*	NL	SC
Leafy pondweed[b]	*Potamogeton foliosus*	NL	SC
Loose water-milfoil[b]	*Myriophyllum laxum*	NL	RC
Milk-pea[b]	*Astragalus villosus*	NL	SC
Nailwort[b,d]	*Paronychia americana*	NL	SC
Nestronia[b]	*Nestronia umbellula*	NL	SC
Nutmeg hickory[b]	*Carya myristiciformis*	NL	RC
Oconee azalea[b]	*Rhododendron flammeum*	NL	SC
Pink tickseed[b]	*Coreopsis rosea*	NL	RC
Quill-leaved swamp potato[b]	*Sagittaria isoetiformis*	NL	SC
Sandhill lily[b]	*Nolina georgiana*	NL	SC
Smooth coneflower[b]	*Echinacea laevigata*	E	—[e]
Trepocarpus[b]	*Trepocarpus aethusae*	NL	SC
Wild water-celery[b]	*Vallisneria americana*	NL	SC
Yellow cress[b]	*Rorippa sessiliflora*	NL	SC
Yellow wild indigo[b]	*Baptisia lanceolata*	NL	SC

[a] Status codes: E - endangered; NL - not listed; RC - regional of concern (unofficial plants only); S/A - protected under the similarity of appearance provision of the *Endangered Species Act*; SC - state of concern; SE - state endangered (official state-listed animals only); ST - state threatened (official state-list animals only); and T - threatened.

[b] Species occurrence recorded on Savannah River Site (SRS).

[c] USFWS Recovery Plan exists for this species.

[d] Species known to occur on Upper Three Runs Creek downstream from the proposed project site or in areas affected by the project.

[e] There is no official state threatened or endangered status for plants; defer to Federal status.

Source: 50 CFR 17.11; 50 CFR 17.12; DOE 1992e; SC WD 1995a; SR NERP 1990b; WSRC 1989e; WSRC 1993b.

TABLE C–3.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found at or in the Vicinity of Pantex Plant*

Common Name	Scientific Name	Status[a]	
		Federal	State
Mammals			
Swift fox[b]	*Vulpes velox*	C	NL
Birds			
American peregrine falcon[c]	*Falco peregrinus anatum*	E	E
Arctic peregrine falcon	*Falco peregrinus tundrius*	E (S/A)	T
Bald eagle[b, c]	*Haliaeetus leucocephalus*	T	E
Interior least tern[c]	*Sterna antillarum athalassos*	E	E
Mountain plover	*Charadrius montanus*	C	NL
White-faced ibis[b]	*Plegadis chihi*	NL	T
Whooping crane[b,c]	*Grus americana*	E	E
Reptiles			
Smooth green snake	*Opheodrys vernalis*	NL	E
Texas horned lizard[b]	*Phrynosoma cornutum*	NL	T

[a] Status codes: C - Federal candidate; E - endangered; NL - not listed; S/A - protected under the similarity of appearances provision of the *Endangered Species Act*; T - threatened.

[b] Species observed on Pantex Plant.

[c] USFWS Recovery Plan exists for this species.

Source: 50 CFR 17.11; 50 CFR 17.12; 61 FR 7596; PX DOE 1996b; PX MH 1994c; TX PWD 1993a; TX PWD 1995a; TX PWD 1995b.

TABLE C–4.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found at or in the Vicinity of Los Alamos National Laboratory* [Page 1 of 2]

Common Name	Scientific Name	Status[a]	
		Federal	State
Mammals			
New Mexican meadow jumping mouse	*Zapus hudsonius luteus*	NL	T
Spotted bat	*Euderma maculatum*	NL	T
Birds			
Baird's sparrow	*Ammodvamus bairdii*	NL	T
Bald eagle[b,c]	*Haliaeetus leucocephalus*	T	T
Broad-billed hummingbird	*Cynanthus latirostris*	NL	T
Common black-hawk	*Beuteogallus anthracinus*	NL	T
Gray vireo	*Vireo vicinior*	NL	T
Mexican spotted owl[c]	*Strix occidentalis lucida*	T	NL
Peregrine falcon[b,c]	*Falcon peregrinus*	E (S/A)	E
Southwestern willow flycatcher	*Empidonax traillii extimus*	E	T
Whooping crane[b]	*Grus americana*	E	E
Amphibians			
Jemez Mountain salamander[c]	*Plethodon neomexicanus*	NL	T
Fish			
Rio Grande silvery minnow	*Hybognathus amarus*	E	T
Invertebrates			
Say's pond snail	*Lymnaea caperata*	NL	E

TABLE C–4.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found at or in the Vicinity of Los Alamos National Laboratory* [Page 2 of 2]

Common Name	Scientific Name	Status[a]	
		Federal	State
Plants			
Checker lily	*Fritillaria atropurpurea*	NL	R
Giant helleborine orchid	*Epipactis gigantea*	NL	RS
Golden lady's slipper	*Cypripedium pubesceas*	NL	E
Sandia alumroot	*Heuchera pulchella*	NL	RS
Santa Fe cholla	*Opuntia viridiflora*	NL	E
Wood lily	*Lilium philadelphicum var. andinum*	NL	E

[a] Status codes: E - endangered; NL - not listed; R - state rare plant review list; RS - state rare and sensitive plant species; S/A - protected under the similarity of appearances provision of the *Endangered Species Act*; T - threatened.

[b] USFWS Recovery Plan exists for this species.

[c] Species recorded on Los Alamos National Laboratory (LANL).

Source: 50 CFR 17.11; 50 CFR17.12; DOE 1995hh; LANL 1996e:2; NM DGF 1990b; NM DGF 1995a; NM FRCD 1995a.

TABLE C–5.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status Speci That May Be Found at or in the Vicinity of the Livermore Site and Site 300* [Page 1 of 2]

Common Name	Scientific Name	Status[a]	
		Federal	State
Mammals			
American badger[b]	*Taxidea taxus*	NL	SC
Greater western mastiff-bat	*Eumops perotis californicus*	NL	SC
Pacific Townsend's big-eared bat	*Plecotus townsendii townsendii*	NL	SC
Riparian brush rabbit	*Sylvilagus bachmani riparius*	C	E
San Francisco dusky-footed woodrat	*Neotoma fuscipes annectens*	NL	SC
San Joaquin kit fox[c]	*Vulpes macrotis mutica*	E	T
San Joaquin pocket mouse[b]	*Perognathus inoratus inoratus*	NL	SC
San Joaquin Valley woodrat	*Neotoma fuscipes riparia*	C	SC
Birds			
American peregrine falcon[b,c]	*Falco peregrinus anatum*	E	E
Bald eagle[c,d]	*Haliaeetus leucocephalus*	T	E
Bell's sage sparrow	*Amphispiza belli belli*	NL	SC
California horned lark[b]	*Eremophila alpestris actia*	NL	SC
Coopers hawk[b,d]	*Accipiter cooperii*	NL	SC
Double-crested cormorant[d]	*Phalacrocorax auritus*	NL	SC
Ferruginous hawk[b,d]	*Buteo regalis*	NL	SC
Golden eagle[b,d]	*Aquila chrysaetos*	NL	SC
Long-eared owl[b]	*Asio otus*	NL	SC
Merlin[b,d]	*Falco columbarius*	NL	SC
Mountain plover	*Charadrius montanus*	C	NL
Northern harrier[b,d]	*Circus cyaneus*	NL	SC
Prairie falcon[b,d]	*Falco mexicanus*	NL	SC
Sharp-shinned hawk[d]	*Accipiter striatus*	NL	SC
Short-eared owl	*Asio flammeus*	NL	SC
Swainson's hawk[b]	*Buteo swainsoni*	NL	T
Tricolored blackbird[b]	*Agelaius tricolor*	NL	SC
Western burrowing owl[b,d]	*Athene cunicularia hypugea*	NL	SC
Reptiles			
Alameda whipsnake[b]	*Masticophis lateralis euryxanthus*	PE	T
California horned lizard[b]	*Phrynosoma coronatum frontale*	NL	SC
Giant garter snake	*Thamnophis gigas*	T	T
Northwestern pond turtle	*Clemmys marmorata marmorata*	NL	SC
San Joaquin whipsnake[b]	*Masticophis flagellum ruddocki*	NL	SC
Silvery legless lizard	*Anniella pulchra pulchra*	NL	SC
Southwestern pond turtle	*Clemmys marmorata pallida*	NL	SC
Amphibians			
California red-legged frog[b]	*Rana aurora draytoni*	PE	SC
California tiger salamander[b]	*Ambystoma californiense*	C	SC
Western spadefoot toad[b]	*Scaphiopus hammondii*	NL	SC

TABLE C–5.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found at or in the Vicinity of the Livermore Site and Site 300* [Page 2 of 2]

Common Name	Scientific Name	Status[a]	
		Federal	State
Invertebrates			
Longhorn fairy shrimp	*Branchinecta longiantenna*	E	NL
Valley elderberry longhorn beetle[b]	*Desmocerus californicus dimorphus*	T	SC
Vernal pool fairy shrimp	*Branchinecta lynchi*	T	NL
Vernal pool tadpole shrimp[c]	*Lepidurus packardi*	E	NL
Plants			
Alkali milkvetch	*Astragalus tener tener*	NL	SC
Big scale balsamroot	*Balsamorhiza macrolepis var. macrolepis*	NL	SC
Congdon's tarplant	*Hemizonia parryi congdonii*	NL	SC
Large-flowered fiddleneck[b]	*Amsinckia grandiflora*	E	E
Palmate-bracted bird's beak	*Cordylanthus palmatus*	E	E
Showy Indian clover	*Trifolium amoenum*	PE	NL
Stinkbells	*Fritillaria agrestis*	NL	SC

[a] Status codes: C - Federal candidate; E - endangered species; NL - not listed; PE - proposed endangered; SC - state species of special concern; T - threatened.

[b] Species considered only for Site 300.

Source: 50 CFR 17.11; 50 CFR 17.12; 61 FR 7596; CA DFG 1994a; CA DFG 1995a; CA DFG 1995b; CA DFG 1995c; LL DOE 1992c; LLNL 1996i:3.

TABLE C–6.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found at or in the Vicinity of Sandia National Laboratories* [Page 1 of 2]

Common Name	Scientific Name	Status[a]	
		Federal	State
Mammals			
New Mexican meadow jumping mouse	*Zapus hudsonius luteus*	NL	T
Spotted bat	*Euderma maculatum*	NL	T
Birds			
Bald eagle[b]	*Haliaeetus leucocephalus*	T	T
Baird's sparrow	*Ammodramus bairdii*	NL	T
Bell's vireo	*Vireo bellii*	NL	T
Common black hawk	*Beuteogallus anthracinus*	NL	T
Gray vireo[c]	*Vireo vicinior*	NL	T
Mexican spotted owl	*Strix occidentalis lucida*	T	NL
Mountain plover	*Charadrius montanus*	C	NL
Northern beardless-tyrannulet	*Camptostoma imperbe*	NL	E
Peregrine falcon[b]	*Falco peregrinus*	E (S/A)	E
Southwestern willow flycatcher	*Empidonax traillii extimus*	E	T
Whooping crane[b]	*Grus americana*	E	E
Fish			
Rio Grande silvery minnow	*Hybognathus amarus*	E	T
Plants			
Great Plains lady tresses	*Spiranthes magnicamporum*	NL	E
Plank's catchfly	*Silene plankii*	NL	RS

TABLE C–6.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found at or in the Vicinity of Sandia National Laboratories* [Page 2 of 2]

Common Name	Scientific Name	Status[a]	
		Federal	State
Santa Fe milkvetch	*Astragalus feensis*	NL	RS
Strong prickly pear	*Opuntia valida*	NL	R

[a] Status codes: C - Federal candidate; E - endangered; NL - not listed; R - state rare plant review list; RS - state rare and sensitive plant species; S/A - protected under the similarity of appearance provision of the *Endangered Species Act*; T - threatened.

[b] USFWS Recovery Plan exists for this species.

[c] Species observed on Sandia National Laboratory (SNL).

Source: 50 CFR 17.11; 50 CFR 17.12; 61 FR 7596; NM DGF 1990b; NM DGF 1995a; NM FRCD 1995a; SNL 1990a; SNL 1992c; SNL 1995h; appendix I.

TABLE C–7.—*Federal- and State-Listed Threatened, Endangered, and Other Special Status Species That May Be Found at or in the Vicinity of Nevada Test Site*

Common Name	Scientific Name	Status[a]	
		Federal	State
Mammals			
Spotted bat[b]	*Euderma maculatum*	NL	T
Birds			
American peregrine falcon[c,d]	*Falco peregrinus anatum*	E	E
Arctic peregrine falcon[c]	*Falco peregrinus tundrius*	E (S/A)	E
Bald eagle[b,d]	*Haliaeetus leucocephalus*	T	T
Mountain plover[b]	*Charadrius montanus*	C	NL
Reptiles			
Desert tortoise [b,e]	*Gopherus agassizii*	T	T
Fish			
Devils Hole pupfish[d,f]	*Cyprinodon diabolis*	E	E
Plants			
Beatley milkvetch[b]	*Astragalus beatleyae*	NL	CE
Mojave fishhook cactus[b]	*Sclerocactus polyancistrus*	NL	CY

[a] Status codes: C - Federal candidate; CE - critically endangered by authority of NRS 527.270 (State Division of Forestry); CY - protected by authority of NRS 522.60–.120 (Nevada Cacti and Yucca Law); E - endangered; NL - not listed; S/A - protected under the similarity of appearances provision of the *Endangered Species Act*; T - threatened.

[b] Species recorded on Nevada Test Site (NTS).

[c] Peregrine falcon seen on NTS; however not identified to subspecies level.

[d] USFWS Recovery Plan exists for this species.

[e] Species known to occur on the proposed project site.

[f] Only known location of this species is outside NTS approximately 55 km (34 mi) southwest of the proposed project site. This species is included here due to offsite groundwater concerns.

Source: 50 CFR 17.11; 50 CFR 17.12; 61 FR 7596; DOE 1995w; NT DOE 1995j; NT DOE 1996c; NT DOI 1995a; NT ERDA 1976a; NV FWS 1989a; NV NHP 1995a.

APPENDIX D

Appendix D

APPENDIX D: SOCIOECONOMICS

D.1 INTRODUCTION

This appendix includes the methodologies, models, assumptions, and supporting data used to assess potential impacts in the socioeconomics sections of this programmatic environmental impact statement. Section D.2 presents the methods and assumptions used to evaluate the potential socioeconomic effects of the proposed alternatives of the Stockpile Stewardship and Management Program. The socioeconomic analysis involved two major steps: (1) characterizing and projecting existing social, economic, and infrastructure conditions surrounding each of the candidate sites (i.e., the affected environment); and (2) evaluating potential changes in socioeconomic conditions that could result from operating the proposed alternatives in the regions addressed (i.e., the environmental consequences).

For each site, socioeconomic impacts were estimated using two geographic areas. First, a region of influence (ROI) was identified based on the distribution of residences for current Department of Energy (DOE) and contractor employees. The ROI is defined as those counties where approximately 90 percent of the workforce lives. This residential distribution reflects existing commuting patterns and attractiveness of area communities for people employed at each site, and was used to estimate the future distribution of direct workers associated with the proposed alternatives.

As an example, table D.1–1 displays the residential distribution by city and county for approximately 90 percent of all personnel employed at Oak Ridge Reservation (ORR). Data on residential locations of a large portion of facility employees were obtained from ORR personnel offices. Similar data were provided by the other locations and are given in tables D.1–2 through D.1–8.

A second geographical area, referred to as a regional economic area, was also identified for estimating socioeconomic impacts. The regional economic area encompasses a broad market that involves trade among regional industrial and service sectors and is characterized by strong economic links between the communities located in the region. These links determine the nature and magnitude of multiplier effects of economic activity at each candidate site. Regional economic areas, as defined by the U.S. Bureau of Economic Analysis, consist of an economic node that serves as the center of economic activity, and surrounding counties that are economically related and include the places of work and residence of its labor force. The regional economic

TABLE D.1–1.—*Distribution of Employees by Place of Residence in the Oak Ridge Reservation Region of Influence, 1991*

County/City	Number of Employees	Total Site Employment (percent)
Anderson County	5,053	33.1
Clinton	1,035	6.8
Oak Ridge	3,292	21.6
Knox County	5,490	36.0
Knoxville	4,835	31.7
Loudon County	848	5.6
Lenoir City	638	4.2
Roane County	2,537	16.6
Harriman	802	5.3
Kingston	1,033	6.8
Total ROI	13,928	91.3

Note: City values are included within county totals.
Source: ORR 1991a:4.

TABLE D.1–2.—*Distribution of Employees by Place of Residence in the Savannah River Site Region of Influence, 1991*

County/City	Number of Employees	Total Site Employment (percent)
Aiken County	9,978	51.9
Aiken	4,928	25.7
North Augusta	2,666	13.9
Barnwell County	1,401	7.3
Columbia County	2,036	10.6
Richmond County	3,358	17.5
Augusta	2,780	14.5
Total ROI	16,773	87.3

Note: City values are included within county totals.
Source: SRS 1991a:3.

TABLE D.1–3.—*Distribution of Employees by Place of Residence in the Kansas City Plant Region of Influence, 1991*

County/City	Number of Employees	Total Site Employment (percent)
Cass County	761	14.0
Belton	237	4.4
Harrisonville	150	2.8
Jackson County	3,246	59.8
Kansas City	1,499	27.6
Lee's Summit	609	11.2
Johnson County	915	16.9
Overland Park	376	6.9
Wyandotte County	135	2.3
Total ROI	5,057	93.2

Note: City values are included within county totals.
Source: KCP 1993a:1.

TABLE D.1–4.—*Distribution of Employees by Place of Residence in the Pantex Plant Region of Influence, 1994*

County/City	Number of Employees	Total Site Employment (percent)
Armstrong County	46	1.3
Carson County	380	10.7
Potter County	1,217	34.2
Amarillo	196	5.5
Randall County	1,783	50.2
Total ROI	3,426	96.4

Note: City values are included within county totals.
Source: PX 1994a:2.

TABLE D.1–5.—*Distribution of Employees by Place of Residence in the Los Alamos National Laboratory Region of Influence, 1991*

County/City	Number of Employees	Total Site Employment (percent)
Los Alamos County	4,697	48.3
Rio Arriba County	2,027	20.8
Espanõla	944	9.7
Santa Fe County	1,851	19.0
Santa Fe	1,548	15.9
Total ROI	8,575	88.1

Note: City values are included within county totals.
Source: LANL 1991b:6.

TABLE D.1–6.—*Distribution of Employees by Place of Residence in the Lawrence Livermore National Laboratory Region of Influence, 1995*

County/City	Number of Employees	Total Site Employment (percent)
Alameda County	4,746	57.1
Livermore	3,215	38.7
Pleasanton	642	7.7
Contra Costa County	1,098	13.2
San Joaquin County	1,327	16.0
Manteca	372	4.5
Tracy	656	7.9
Total ROI	7,171	86.3

Note: City values are included within county totals.
Source: LLNL 1995i:1.

TABLE D.1–7.—*Distribution of Employees by Place of Residence in the Sandia National Laboratories Region of Influence, 1994*

County/City	Number of Employees	Total Site Employment (percent)
Bernalillo County	6,463	88.0
Albuquerque	6,030	82.1
Sandoval County	333	4.5
Valencia County	334	4.5
Total ROI	7,130	97.0

Note: City values are included within county totals.
Source: SNL 1995b:1.

TABLE D.1–8.—*Distribution of Employees by Place of Residence in the Nevada Test Site Region of Influence, 1991*

County/City	Number of Employees	Total Site Employment (percent)
Clark County	6,270	81.7
Henderson	357	4.7
Las Vegas	5,352	69.7
North Las Vegas	505	6.6
Nye County	1,173	15.3
Total ROI	7,443	97.0

Note: City values are included within county totals.
Source: NTS 1991a:1.

area is used to analyze the primary economic impacts on employment, spending, earnings, and personal income. Table D.1–9 displays the counties found in each site's regional economic area.

Data for the year 1992 or later were obtained from sources such as the U.S. Bureau of Census, the U.S. Bureau of Economic Analysis (BEA), state and local government publications, and telephone interviews with state and local government officials and planners.

D.2 METHODOLOGIES AND MODELS

D.2.1 Employment and Population

The description of socioeconomic conditions includes indicators, such as population, civilian labor force, employment, unemployment rate, and income. These indicators provide a basis for comparing baseline projections of the affected regions to estimates of project-induced impacts. These baseline projections depict the No Action alternative. The baseline projections are derived from forecasts for the project period developed with data from BEA.

An analysis of the existing labor availability was performed to determine the number of workers that would be needed to come from outside the region. In addition to jobs created directly by the proposed project alternatives, other jobs and opportunities are created indirectly within the region. These indirect jobs and resulting income are measured by employing the most recent version of the Regional Input-Output Modeling System developed by BEA. For this analysis, direct effect multipliers were used to determine project-related additional indirect workers and earnings increases. Final demand multipliers were not used because there were not sufficient data on purchases. Population increases due to the in-migration of new workers and their families are estimated by the number of new workers and the national average household size because this new population would come from unknown places outside the region.

Total employment and local economic data for all the sites are given in tables D.2.1–1 through D.2.1–8. Population data for all the sites are given in tables D.2.1–9 through D.2.1–16.

TABLE D.1–9.—*Candidate Sites' Regional Economic Areas*

ORR	SRS	KCP			Pantex		LANL	LLNL		SNL	NTS
Tennessee	**Georgia**	**Kansas**	**Missouri (Con't)**	**Missouri (Con't)**	**New Mexico**	**Texas (Con't)**	**New Mexico**	**California**	**California (Con't)**	**Arizona**	**Arizona**
Anderson	Burke	Anderson	Caldwell	Livingston	Curry	Gray	Guadalupe	Alameda	Stanislaus	Apache	Mohave
Blount	Columbia	Atchison	Carroll	Macon	Debaca	Hall	Los Alamos	Calaveras	Trinity		
Campbell	Glascock	Bourbon	Cass	Mercer	Harding	Hansford	Mora	Contra Costa	Tuolumne		
Cocke	Jefferson	Doniphan	Cedar	Nodaway	Quay	Hartley	Rio Arriba	Humboldt		**New Mexico**	**Nevada**
Grainger	Jenkins	Douglas	Chariton	Pettis	Roosevelt	Hemphill	San Miguel	Lake		Bernalillo	Clark
Hamblen	Lincoln	Franklin	Clay	Platte	Union	Hutchinson	Santa Fe	Marin		Catron	Esmeralda
Hancock	McDuffie	Johnson	Clinton	Putnam		Lipscomb	Taos	Mariposa		Cibola	Lincoln
Jefferson	Richmond	Leavenworth	Davies	Ray		Moore		Mendocino		McKinley	Mineral
Knox	Warren	Linn	De Kalb	Saline	**Texas**	Ochiltree		Merced		Sandoval	Nye
Loudon	Wilkes	Miami	Gentry	Schuyler	Armstrong	Oldham		Monterey		Socorro	
Morgan		Wyandotte	Grundy	St. Clair	Bailey	Parmer		Napa		Torrance	
Roane			Harrison	Sullivan	Carson	Potter		San Benito		Valencia	**Utah**
Scott	**South Carolina**		Henry	Vernon	Castro	Randall		San Francisco			Beaver
Sevier	Aiken	**Missouri**	Holt	Worth	Childress	Roberts		San Joaquin			Garfield
Union	Allendale	Adair	Jackson		Collingsworth	Sherman		San Mateo			Iron
	Bamberg	Andrew	Johnson		Cottle	Wheeler		Santa Clara			Piute
	Barnwell	Bates	Knox		Dallam			Santa Cruz			Washington
	Edgefield	Benton	Lafayette		Deaf Smith			Solano			
		Buchanan	Linn		Donley			Sonoma			

Source: DOC 1995a.

TABLE D.2.1–1.—*Employment and Local Economy for the Oak Ridge Reservation Regional Economic Area, No Action Alternative, 1995-2030*

Regional Economic Area	1995	2000	2005	2010	2020	2030
Civilian labor force	486,400	513,600	535,800	555,300	594,000	601,300
Total employment	462,900	488,700	509,800	528,400	565,200	572,100
Unemployment rate (percentage)	4.9	4.9	4.9	4.9	4.9	4.9
Total personal income (thousand dollars)	16,498,303	18,391,177	20,017,623	21,498,098	24,601,119	25,206,968
Per capita income (dollars per person)	18,198	19,214	20,046	20,774	22,223	22,494

Source: Census 1993a; Census 1993b; DOC 1990c; DOC 1990d; DOC 1994j; DOC 1995a; DOL 1991a; DOL 1995a; OR LMES 1996i; ORR 1995a:1.

TABLE D.2.1–2.— *Employment and Local Economy for the Savannah River Site Regional Economic Area, No Action Alternative, 1995-2030*

Regional Economic Area	1995	2000	2005	2010	2020	2030
Civilian labor force	261,400	278,100	292,300	306,100	335,600	338,500
Total employment	243,800	259,400	272,700	285,500	313,000	315,800
Unemployment rate (percentage)	6.7	6.7	6.7	6.7	6.7	6.7
Total personal income (thousand dollars)	10,608,794	12,013,250	13,269,987	14,550,516	17,487,856	17,798,751
Per capita income (dollars per person)	17,789	18,930	19,895	20,833	22,839	23,041

Source: Census 1993a; Census 1993c; Census 1993e; DOC 1990c; DOC 1990d; DOC 1994j; DOC 1995a; DOE 1995p; DOL 1991a; DOL 1995a; SR DOE 1995b; SRS 1995a:1.

TABLE D.2.1–3.—*Employment and Local Economy for the Kansas City Plant Regional Economic Area, No Action Alternative, 1995-2030*

Regional Economic Area	1995	2000	2005	2010	2020	2030
Civilian labor force	1,215,800	1,255,900	1,296,200	1,338,900	1,428,200	1,444,000
Total employment	1,156,200	1,194,400	1,232,700	1,273,400	1,358,300	1,373,300
Unemployment rate (percentage)	4.9	4.9	4.9	4.9	4.9	49
Total personal income (thousand dollars)	46,020,762	49,151,226	52,309,800	55,815,538	63,506,729	64,919,757
Per capita income (dollars per person)	20,004	20,683	21,327	22,030	23,499	23,759

Source: Census 1993a; Census 1993q; Census 1993t; DOC 1990c; DOC 1990d; DOC 1994j; DOC 1995a; DOL 1991a; DOL 1995a; KCP 1995a:1.

TABLE D.2.1–4.—*Employment and Local Economy for the Pantex Plant Regional Economic Area, No Action Alternative, 1995-2030*

Regional Economic Area	1995	2000	2005	2010	2020	2030
Civilian labor force	234,700	247,800	261,100	274,800	302,300	302,000
Total employment	223,300	235,800	248,400	261,500	287,700	287,400
Unemployment rate (percentage)	4.8	4.8	4.8	4.8	4.8	4.8
Total personal income (thousand dollars)	9,622,309	10,728,135	11,908,766	13,190,906	15,965,800	15,933,429
Per capita income (dollars per person)	19,987	21,104	22,235	23,401	25,745	25,719

Source: Census 1993a; Census 1993m; Census 1993w; DOC 1990c; DOC 1990d; DOC 1994j; DOC 1995a; DOL 1991a; DOL 1995a; PX 1995a:2.

TABLE D.2.1–5.—*Employment and Local Economy for the Los Alamos National Laboratory Regional Economic Area, No Action Alternative, 1995-2030*

Regional Economic Area	1995	2000	2005	2010	2020	2030
Civilian labor force	119,700	130,800	140,900	150,400	169,400	175,200
Total employment	112,300	122,700	132,200	141,100	158,900	164,400
Unemployment rate (percentage)	6.2	6.2	6.2	6.2	6.2	6.2
Total personal income (thousand dollars)	4,218,781	5,034,646	5,845,041	6,655,720	8,440,189	9,034,538
Per capita income (dollars per person)	18,314	20,007	21,557	23,003	25,904	26,801

Source: Census 1993a; Census 1993m; DOC 1990c; DOC 1990d; DOC 1994j; DOC 1995a; DOL 1991a; DOL 1995a; LANL 1995b:1.

TABLE D.2.1–6.— *Employment and Local Economy for the Lawrence Livermore National Laboratory Regional Economic Area, No Action Alternative, 1995-2030*

Regional Economic Area	1995	2000	2005	2010	2020	2030
Civilian labor force	4,556,000	5,004,100	5,448,100	5,917,500	6,992,100	7,097,200
Total employment	4,208,100	4,621,900	5,032,000	5,465,600	6,458,200	6,555,300
Unemployment rate (percentage)	7.6	7.6	7.6	7.6	7.6	7.6
Total personal income (thousand dollars)	236,627,513	285,131,842	337,968,862	398,727,427	556,687,763	573,557,669
Per capita income (dollars per person)	26,716	29,310	31,910	34,660	40,954	41,570

Source: Census 1993a; Census 1993x; DOC 1990c; DOC 1990d; DOC 1994j; DOC 1995a; DOL 1991a; DOL 1995a; LLNL 1995i:1.

TABLE D.2.1–7.—*Employment and Local Economy for the Sandia National Laboratories Regional Economic Area, No Action Alternative, 1995-2030*

Regional Economic Area	1995	2000	2005	2010	2020	2030
Civilian labor force	408,300	446,100	480,600	512,900	577,500	597,500
Total employment	385,200	420,900	453,500	483,900	544,900	563,800
Unemployment rate (percentage)	5.7	5.7	5.7	5.7	5.7	5.7
Total personal income (thousand dollars)	14,923,362	17,809,373	20,676,034	23,543,700	29,856,016	31,958,442
Per capita income (dollars per person)	17,676	19,310	20,806	22,202	25,002	25,867

Source: Census 1993a; Census 1993f; Census 1993m; DOC 1990c; DOC 1990d; DOC 1994j; DOC 1995a; DOL 1991a; DOL 1995a; SNL 1995b:1.

TABLE D.2.1–8.—*Employment and Local Economy for the Nevada Test Site Regional Economic Area, No Action Alternative, 1995-2030*

Regional Economic Area	1995	2000	2005	2010	2020	2030
Civilian labor force	648,600	747,100	814,100	861,900	959,500	993,200
Total employment	608,900	701,400	764,300	809,100	900,800	932,400
Unemployment rate (percentage)	6.1	6.1	6.1	6.1	6.1	6.1
Total personal income (thousand dollars)	27,397,938	36,357,995	43,164,854	48,380,917	59,961,996	64,253,190
Per capita income (dollars per person)	22,083	25,438	27,718	29,345	32,669	33,817

Source: Census 1993a; Census 1993f; Census 1993y; Census 1993z; DOC 1990c; DOC 1990d; DOC 1994j; DOC 1995a; DOL 1991a; DOL 1995a; NTS 1995a:1.

TABLE D.2.1–9.—*Population for the Oak Ridge Reservation Region of Influence, No Action Alternative, 1995-2030*

County/City	1995	2000	2005	2010	2020	2030
Anderson County	73,300	77,400	80,800	83,700	89,500	90,600
Clinton	9,900	10,400	10,900	11,300	12,000	12,200
Oak Ridge	26,300	27,800	29,000	30,000	32,100	32,500
Knox County	361,400	381,500	398,100	412,500	441,300	446,700
Knoxville	173,900	183,600	191,600	198,500	212,400	215,000
Loudon County	34,600	36,500	38,100	39,500	42,200	42,700
Lenoir City	7,100	7,500	7,800	8,100	8,600	8,700
Roane County	50,000	52,800	55,100	57,100	61,100	61,800
Harriman	7,400	7,900	8,200	8,500	9,100	9,200
Kingston	4,800	5,100	5,300	5,500	5,900	6,000
Total ROI	519,300	548,200	572,100	592,800	634,100	641,800

Note: City values are included in county totals.

Source: Census 1993a; Census 1993b; DOC 1990c; DOC 1990d; DOC 1994j.

TABLE D.2.1–10.—*Population for the Savannah River Site Region of Influence, No Action Alternative, 1995-2030*

County/City	1995	2000	2005	2010	2020	2030
Aiken County	135,300	144,000	151,300	158,500	173,700	175,300
Aiken	23,600	25,100	26,400	27,600	30,300	30,600
North Augusta	17,200	18,300	19,300	20,200	22,100	22,300
Barnwell County	22,200	23,600	24,800	26,000	28,500	28,700
Columbia County	76,800	81,800	85,900	90,000	98,600	99,500
Richmond County	213,000	226,700	238,300	249,500	273,400	275,900
Augusta	46,800	49,800	52,300	54,800	60,100	60,600
Total ROI	447,300	476,100	500,300	524,000	574,200	579,400

Note: City values are included in county totals.

Source: Census 1993a; Census 1993c; Census 1993e; DOC 1990c; DOC 1990d; DOC 1994j.

TABLE D.2.1–11.—*Population for the Kansas City Plant Region of Influence, No Action Alternative, 1995-2030*

County/City	1995	2000	2005	2010	2020	2030
Cass County	68,700	70,900	73,200	75,600	80,700	81,600
Belton	19,800	20,400	21,100	21,800	23,200	23,500
Harrisonville	8,200	8,500	8,800	9,100	9,700	9,800
Jackson County	645,400	666,700	688,100	710,800	758,200	766,600
Kansas City	439,300	453,800	468,400	483,800	516,000	521,800
Lee's Summit	52,200	54,000	55,700	57,500	61,400	62,100
Johnson County	381,900	394,500	407,100	420,600	448,600	453,600
Overland Park	121,400	125,400	129,400	133,700	142,600	144,200
Wyandott County	161,600	166,900	172,200	177,900	189,800	191,900
Total ROI	1,257,600	1,299,000	1,340,600	1,384,900	1,477,300	1,493,700

Note: City values are included in county totals.

Source: Census 1993a; Census 1993q; Census 1993t; DOC 1990c; DOC 1990d; DOC 1994j.

TABLE D.2.1–12.—*Population for the Pantex Plant Region of Influence, No Action Alternative, 1995-2030*

County/City	1995	2000	2005	2010	2020	2030
Armstrong County	2,100	2,200	2,300	2,500	2,700	2,700
Carson County	6,800	7,200	7,600	8,000	8,800	8,800
Potter County	105,000	110,900	116,800	122,900	135,200	135,100
Amarillo	169,500	179,000	188,600	198,500	218,400	218,100
Randall County	96,700	102,100	107,600	113,200	124,500	124,400
Total ROI	210,600	222,400	234,300	246,600	271,200	271,000

Note: Amarillo is divided across Potter and Randall Counties. The population shown for Amarillo is for the whole city. Potter and Randall County totals represent their share of Amarillo.

Source: Census 1993a; Census 1993w; DOC 1990c; DOC 1990d; DOC 1994j.

TABLE D.2.1–13.—*Population for the Los Alamos National Laboratory Region of Influence, No Action Alternative, 1995-2030*

County/City	1995	2000	2005	2010	2020	2030
Los Alamos County	19,200	21,000	22,600	24,200	27,200	28,200
Rio Arriba County	36,900	40,300	43,500	46,400	52,200	54,000
Espanola	9,600	10,400	11,200	12,000	13,500	14,000
Santa Fe County	111,300	121,600	131,000	139,800	157,500	162,900
Santa Fe	62,500	68,200	73,500	78,400	88,300	91,400
Total ROI	167,400	182,900	197,100	210,400	236,900	245,100

Note: City values are included in county totals.

Source: Census 1993a; Census 1993m; DOC 1990c; DOC 1990d; DOC 1994j.

TABLE D.2.1–14.—*Population for the Lawrence Livermore National Laboratory Region of Influence, No Action Alternative, 1995-2030*

County/City	1995	2000	2005	2010	2020	2030
Alameda County	1,400,700	1,536,800	1,673,100	1,817,300	2,147,300	2,179,600
Livermore	64,300	70,600	76,800	83,500	98,600	100,100
Pleasanton	58,100	63,700	69,400	75,400	89,000	90,400
Contra Costa County	900,500	987,900	1,075,600	1,168,200	1,380,400	1,401,200
San Joaquin County	540,000	592,400	645,000	700,600	827,800	840,300
Manteca	45,500	49,900	54,300	59,000	69,700	70,800
Tracy	41,900	46,000	50,100	54,400	64,300	65,200
Total ROI	2,841,200	3,117,100	3,393,700	3,686,100	4,355,500	4,421,000

Note: City values are included in county totals.

Source: Census 1993a; Census 1993m; DOC 1990c; DOC 1990d; DOC 1994j.

TABLE D.2.1–15.—*Population for the Sandia National Laboratories Region of Influence, No Action Alternative, 1995-2030*

County/City	1995	2000	2005	2010	2020	2030
Bernalillo County	529,000	577,900	622,600	664,400	748,200	774,100
Albuquerque	422,200	461,200	497,000	530,300	597,200	617,800
Sandoval County	72,900	79,600	85,800	91,500	103,100	106,600
Valencia County	51,200	55,900	60,200	64,300	72,400	74,900
Total ROI	653,100	713,400	768,600	820,200	923,700	955,600

Note: City values are included in county totals.

Source: Census 1993a; Census 1993m; DOC 1990c; DOC 1990d; DOC 1994j.

TABLE D.2.1–16.—*Population for the Nevada Test Site Region of Influence, No Action Alternative, 1995-2030*

County/City	1995	2000	2005	2010	2020	2030
Clark County	941,100	1,084,100	1,181,200	1,250,500	1,392,900	1,441,100
Henderson	93,900	108,100	117,800	124,800	139,000	143,800
Las Vegas	328,900	378,800	412,800	437,000	486,800	503,600
North Las Vegas	61,800	71,200	77,600	82,200	91,500	94,700
Nye County	21,700	25,000	27,300	28,900	32,100	33,300
Total ROI	962,800	1,109,100	1,208,500	1,279,400	1,425,000	1,474,400

Note: City values are included in county totals.

Source: Census 1993a; Census 1993y; DOC 1990c; DOC 1990d; DOC 1994j.

D.2.2 Housing

No action housing characteristics are presented in tables D.2.2–1 through D.2.2–8. Projected housing needs are based upon housing unit and population data obtained from the 1990 Census of Population and Housing for each ROI. Future housing units needed for cities and counties in each ROI were developed by estimating the household size from the current population and housing unit ratios. The household size to population ratios were then applied to the estimated future population trends to obtain the number of housing units needed to accommodate the projected population for a No Action alternative future baseline.

Projected housing needs for the proposed alternatives were derived by a similar method, but a national average population-to-housing ratio was used. The additional housing needed for the estimated in-migrating workforce and their families are calculated after vacancy rates for the affected region are reduced to the lowest historical level. Past housing construction trends are also evaluated to assess potential impacts.

TABLE D.2.2–1.—*Owner and Renter Housing Units for the Oak Ridge Reservation Region of Influence, No Action Alternative, 1995-2030*

County/City	1995	2000	2005	2010	2020	2030
Anderson County	30,500	32,200	33,600	34,900	37,300	37,700
Clinton	4,300	4,600	4,700	4,900	5,300	5,300
Oak Ridge	11,000	11,600	12,100	12,600	13,500	13,600
Knox County	150,400	158,800	165,600	171,700	183,600	185,900
Knoxville	78,000	82,400	86,000	89,100	95,300	96,500
Loudon County	13,900	14,600	15,300	15,800	16,900	17,100
Lenoir City	3,100	3,200	3,400	3,500	3,700	3,800
Roane County	20,300	21,400	22,300	23,100	24,700	25,000
Harriman	3,200	3,400	3,500	3,700	3,900	4,000
Kingston	2,100	2,300	2,400	2,500	2,600	2,700
Total ROI	215,100	227,000	236,800	245,500	262,500	265,700

Note: City values are included in county totals.
Source: Census 1991c; appendix table D.2.1–9.

TABLE D.2.2–2.—*Owner and Renter Housing Units for the Savannah River Site Region of Influence, No Action Alternative, 1995-2030*

County/City	1995	2000	2005	2010	2020	2030
Aiken County	52,600	56,000	58,800	61,600	67,500	68,100
Aiken	9,800	10,400	10,900	11,400	12,500	12,600
North Augusta	7,500	8,000	8,400	8,800	9,600	9,700
Barnwell County	8,100	8,600	9,000	9,500	10,400	10,500
Columbia County	26,400	28,000	29,500	30,900	33,800	34,100
Richmond County	81,800	87,000	91,500	95,800	105,000	105,900
Augusta	21,100	22,400	23,600	24,700	27,000	27,300
Total ROI	168,900	179,600	188,800	197,800	216,700	218,600

Note: City values are included in county totals.
Source: Census 1991a; Census 1991b; appendix table D.2.1–10.

TABLE D.2.2–3.— *Owner and Renter Housing Units for the Kansas City Plant Region of Influence, No Action Alternative, 1995-2030*

County/City	1995	2000	2005	2010	2020	2030
Cass County	25,500	26,400	27,200	28,100	30,000	30,300
Belton	7,300	7,500	7,800	8,000	8,500	8,600
Harrisonville	4,200	4,300	4,400	4,600	4,900	4,900
Jackson County	276,300	285,500	294,600	304,300	324,600	328,200
Kansas City	195,600	202,000	208,500	215,400	229,700	232,300
Lee's Summit	38,200	39,400	40,700	42,000	44,800	45,300
Johnson County	153,100	158,100	163,200	168,600	179,800	181,800
Overland Park	51,400	53,100	54,800	56,600	60,300	61,000
Wyandotte County	66,800	69,000	71,200	73,600	78,500	79,400
Total ROI	521,700	539,000	556,200	574,600	612,900	619,700

Note: City values are included in county totals.
Source: Census 1991f; Census 1991ff; appendix table D.2.1–11.

TABLE D.2.2–4.—*Owner and Renter Housing Units for the Pantex Plant Region of Influence, No Action Alternative, 1995-2030*

County/City	1995	2000	2005	2010	2020	2030
Armstrong County	800	900	900	1,000	1,100	1,100
Carson County	2,700	2,800	3,000	3,200	3,500	3,500
Potter County	44,000	46,400	48,900	51,500	56,600	56,600
Amarillo	71,300	75,200	79,300	83,400	91,800	91,700
Randall County	39,600	41,800	44,000	46,300	51,000	50,900
Total ROI	87,100	91,900	96,800	102,000	112,200	112,100

Note: Amarillo is divided across Potter and Randall Counties. The number of housing units shown for Amarillo is for the whole city. Potter and Randall County totals represent their share of Amarillo.
Source: Census 1991m; appendix table D.2.1–12.

TABLE D.2.2–5.—*Owner and Renter Housing Units for the Los Alamos National Laboratory Region of Influence, No Action Alternative, 1995-2030*

County/City	1995	2000	2005	2010	2020	2030
Los Alamos County	8,000	8,800	9,500	10,100	11,400	11,800
Rio Arriba County	15,400	16,900	18,200	19,400	21,800	22,600
Espanola	1,000	1,100	1,200	1,300	1,500	1,500
Santa Fe County	46,700	51,000	54,900	58,600	66,000	68,300
Santa Fe	27,600	30,100	32,500	34,700	39,000	40,400
Total ROI	70,100	76,700	82,600	88,100	99,200	102,700

Note: City values are included in county totals.
Source: Census 1991h; appendix table D.2.1–13.

TABLE D.2.2–6.—*Owner and Renter Housing Units for the Lawrence Livermore National Laboratory Region of Influence, No Action Alternative, 1995-2030*

County/City	1995	2000	2005	2010	2020	2030
Alameda County	543,300	596,100	649,000	704,900	832,900	845,400
Livermore	24,200	26,500	28,900	31,400	37,100	37,600
Pleasanton	22,100	24,200	26,400	28,700	33,900	34,400
Contra Costa County	347,800	381,600	415,500	451,300	533,200	541,200
San Joaquin County	183,100	200,900	218,700	237,600	280,700	284,900
Manteca	10,400	11,400	12,400	13,500	16,000	16,200
Tracy	14,900	16,300	17,800	19,300	22,800	23,200
Total ROI	1,074,200	1,178,600	1,283,200	1,393,800	1,646,800	1,671,500

Note: City values are included in county totals.
Source: Census 1991j; appendix table D.2.1–14.

TABLE D.2.2–7.—*Owner and Renter Housing Units for the Sandia National Laboratories Region of Influence, No Action Alternative, 1995-2030*

County/City	1995	2000	2005	2010	2020	2030
Bernalillo County	221,500	242,000	260,700	278,200	313,300	324,100
Albuquerque	183,100	200,000	215,500	230,000	259,000	268,000
Sandoval County	27,200	29,800	32,100	34,200	38,500	39,900
Valencia County	19,000	20,700	22,300	23,800	26,900	27,800
Total ROI	267,700	292,500	315,100	336,200	378,700	391,800

Note: City values are included in county totals.
Source: Census 1991h; appendix table D.2.1–15.

TABLE D.2.2–8.—*Owner and Renter Housing Units for the Nevada Test Site Region of Influence, No Action Alternative, 1995-2030*

County/City	1995	2000	2005	2010	2020	2030
Clark County	383,700	442,000	481,600	509,800	567,900	587,500
Henderson	35,700	41,100	44,800	47,500	52,900	54,700
Las Vegas	136,400	157,100	171,200	181,200	201,800	208,800
North Las Vegas	19,900	22,900	25,000	26,400	29,400	30,500
Nye County	8,600	9,900	10,800	11,400	12,800	13,200
Total ROI	392,300	451,900	492,400	521,200	580,700	600,700

Note: City values are included in county totals.
Source: Census 1991g; appendix table D.2.1–16.

D.2.3 Public Finance

Finances of ROI local jurisdictions were evaluated based on changes in historic revenue and expenditure levels, changes in fund balances, and reserve bonding capabilities. These historic fiscal characteristics were obtained from financial audits and budgets supplied by each jurisdiction. The analysis concentrated on each jurisdiction's governmental funds (general funds, special revenue funds, and, as applicable, capital projects, debt service, and expendable trust funds). Other funds, such as enterprise funds, which are funded principally through user charges without contributing to the general tax burden of area residents, were not included in the analysis. The analysis of local jurisdictions' public finances focused upon revenues and expenditures because no assumptions could be made for some projected fund balances (such as capital expenditures) so far into the future.

The following parameters were used to project changes in total revenues and expenditures: gains (or losses) of jobs in the region; population increases (or decreases) in each jurisdiction, including school districts; earnings and income gains (or losses); and potential changes in each jurisdiction's property tax base. Public finance and No Action characteristics are presented in tables D.2.3–1 through D.2.3–15.

TABLE D.2.3–1.—*County and City Revenues and Expenditures for the Oak Ridge Reservation Region of Influence, 1994*

Revenues and Expenditures	Anderson County	Clinton	Oak Ridge	Knox County	Knoxville	Loudon County	Lenoir City	Roane County	Harriman	Kingston
Property tax (percent)	40	62	22	54	73	37	30	40	32	60
State shared and intergovernmental (percent)	48	27	69	36	20	52	61	49	49	30
Permits, fees, fines, and investment interest (percent)	12	2	5	2	5	8	6	9	4	3
Other (percent)	0	9	4	8	2	3	3	2	15	7
Total Revenues (dollars)	50,802,902	5,320,132	41,367,745	358,355,159	118,642,146	25,630,923	10,820,645	35,658,903	13,700,152	1,978,190
General government (percent)	23	26	2	23	6	20	8	15	6	36
Public safety, health, and community services (percent)	0	19	11	0	39	0	9	0	13	62
Public works, parks, culture, and recreation (percent)	5	26	14	2	30	8	10	5	11	0
Debt services (percent)	0	15	5	6	16	11	5	6	12	2
Education (percent)	51	0	62	60	5	57	67	59	54	0
Capital outlay (percent)	21	14	6	9	4	4	1	15	4	0
Other (percent)	0	0	0	0	0	0	0	0	0	0
Total Expenditures (dollars)	58,487,767	5,768,608	45,633,111	374,478,124	103,877,538	27,201,056	10,581,424	41,289,602	13,236,429	1,784,915
End-of-Year Fund Balance (dollars)	16,460,005	4,015,490	18,299,359	50,735,073	32,350,878	4,533,445	2,122,270	7,560,278	1,758,760	511,138

Note: Financial information for ORR school districts is included in county and city financial audits.
Source: OR City 1995b; OR County 1995a.

TABLE D.2.3–2.—*County and City Revenues and Expenditures for the Savannah River Site Region of Influence, 1994*

Revenues and Expenditures	Aiken County, SC	Aiken	North Augusta	Barnwell County, SC	Columbia County, GA	Richmond County, GA	Augusta
Property tax (percent)	53	40	45	24	70	79	59
State shared and intergovernmental (percent)	31	7	10	74	4	0	20
Permits, fees, fines, and investment interest (percent)	7	49	41	0	12	14	9
Other (percent)	9	4	4	2	14	7	12
Total Revenues (dollars)	35,159,759	14,240,252	6,615,993	7,429,225	32,547,657	87,277,685	33,975,011
General government (percent)	10	7	17	40	9	11	20
Public safety, health, and community services (percent)	34	28	38	34	36	44	28
Public works, parks, culture, and recreation (percent)	20	27	32	20	22	18	18
Debt services (percent)	11	2	5	0	2	10	7
Education (percent)	5	0	0	0	0	0	0
Capital outlay (percent)	14	20	8	0	21	17	19
Other (percent)	6	16	0	6	10	0	8
Total Expenditures (dollars)	35,790,029	14,322,339	6,810,049	5,146,577	34,607,926	81,414,049	48,712,791
End-of-Year Fund Balance (dollars)	16,594,477	11,204,482	2,609,106	8,274,191	11,649,564	77,244,431	11,725,730

Source: SR City 1995a; SR County 1995a.

TABLE D.2.3–3.—*School District Revenues and Expenditures for the Savannah River Site Region of Influence, 1994*

Revenues and Expenditures	Aiken County, SC	Barnwell County #19, SC	Barnwell County #29, SC	Barnwell County #45, SC	Columbia County, GA	Richmond County, GA
Local sources (percent)	39	21	34	33	36	35
State sources (percent)	55	69	58	58	60	54
Federal sources (percent)	6	10	8	9	4	11
Other (percent)	0	0	0	0	0	0
Total Revenues (dollars)	101,336,443	5,453,008	4,627,943	11,409,161	67,786,080	162,652,868
Total instruction (percent)	52	57	39	60	57	59
Support services (percent)	27	39	24	28	26	30
Food, community, and other services (percent)	2	2	1	1	6	7
Capital assets (percent)	10	0	32	0	5	1
Debt services (percent)	9	2	4	11	6	3
Total Expenditures (dollars)	113,866,054	5,413,238	6,981,754	11,343,781	70,300,960	157,087,533
End-of-Year Fund Balance (dollars)	15,139,008	764,024	671,935	1,866,666	33,103,796	33,919,859

Source: SR School 1995b.

TABLE D.2.3–4.—*County and City Revenues and Expenditures for the Kansas City Plant Region of Influence, 1994*

Revenues and Expenditures	Cass County	Belton	Harrisonville	Jackson County	Kansas City	Lee's Summit	Johnson County	Overland Park	Wyandotte County
Property tax (percent)	NA	63	63	74	56	67	54	67	NA
State shared and intergovernmental (percent)	NA	8	1	10	9	18	19	14	NA
Permits, fees, fines, and investment interest (percent)	NA	10	31	13	28	11	19	13	NA
Other (percent)	NA	19	5	3	7	4	8	6	NA
Total Revenues (dollars)	NA	7,081,222	4,070,287	109,755,131	480,601,000	25,369,494	162,258,423	77,024,187	NA
General government (percent)	NA	11	17	54	6	9	19	10	NA
Public safety, health, and community services (percent)	NA	44	51	29	24	41	39	24	NA
Public works, parks, culture, and recreation (percent)	NA	22	28	15	33	22	16	29	NA
Debt services (percent)	NA	15	2	2	11	12	8	11	NA
Capital outlay (percent)	NA	8	0	0	11	16	18	26	NA
Other (percent)	NA	0	2	0	15	0	0	0	NA
Total Expenditures (dollars)	NA	6,498,171	3,385,267	109,901,97	459,477,00	23,522,269	157,076,221	80,500,054	NA
End-of-Year Fund Balance (dollars)	NA	3,637,533	4,301,121	60,948,809	276,086,000	20,044,897	77,735,985	60,793,238	NA

Note: NA - not available.

Source: KC City 1995a; KC County 1995a.

TABLE D.2.3–5.—*School District Revenues and Expenditures for the Kansas City Plant Region of Influence, 1994*

Revenues and Expenditures	Belton	Center	Harrisonville	Hickman Hills	Kansas City	Lee's Summit	Unified School District #229
Local sources (percent)	49	81	55	59	40	NA	65
State sources (percent)	45	15	36	36	53	NA	28
Federal sources (percent)	6	4	5	4	7	NA	1
Other (percent)	0	0	4	1	0	NA	6
Total Revenues (dollars)	18,578,226	16,923,736	11,735,893	38,744,073	371,171,282	NA	80,571,877
Total instruction (percent)	59	57	53	62	41	NA	50
Support services (percent)	26	37	32	25	35	NA	24
Food, community, and other services (percent)	10	1	5	9	11	NA	4
Capital assets (percent)	0	4	2	1	7	NA	9
Debt services (percent)	5	1	8	3	6	NA	13
Total Expenditures (dollars)	17,802,120	17,134,971	11,425,842	40,641,975	368,956,267	NA	80,034,572
End-of-Year Fund Balance (dollars)	5,261,823	6,094,505	3,268,301	9,066,453	217,966,000	NA	67,979,753

Note: NA - not available.
Source: KC School 1995a.

TABLE D.2.3–6.—*County and City Revenues and Expenditures for the Pantex Plant Region of Influence, 1994*

Revenues and Expenditures	Armstrong County	Carson County	Potter County	Amarillo	Randall County
Property tax (percent)	34	65	66	59	55
State shared and intergovernmental (percent)	17	2	9	11	13
Permits, fees, fines, and investment interest (percent)	46	26	20	18	30
Other (percent)	3	7	5	12	2
Total Revenues (dollars)	749,995	1,829,229	21,516,628	76,603,713	13,065,681
General government (percent)	31	46	15	7	18
Public safety, health, and community services (percent)	32	35	57	38	59
Public works, parks, culture, and recreation (percent)	30	5	11	45	4
Debt services (percent)	4	0	7	2	4
Capital outlay (percent)	3	9	5	8	5
Other (percent)	0	5	5	0	10
Total Expenditures (dollars)	746,983	2,585,350	19,633,506	69,837,313	11,968,123
End-of-Year Fund Balance (dollars)	593,463	18,239	20,960,491	52,263,778	5,011,059

Source: PX City 1995a; PX County 1995a.

TABLE D.2.3–7.—*School District Revenues and Expenditures for the Pantex Plant Region of Influence, 1994*

Revenues and Expenditures	Amarillo	Canyon	Claude	Groom	Highland Park	Panhandle	White Deer
Local sources (percent)	43	48	42	55	89	82	92
State sources (percent)	49	47	54	40	6	14	4
Federal sources (percent)	8	5	4	5	5	4	4
Other (percent)	0	0	0	0	0	0	0
Total Revenues (dollars)	129,782,359	27,248,718	2,196,573	1341,890	3,932,722	4,388,125	2,684,692
Total instruction (percent)	58	49	56	55	55	58	57
Support services (percent)	26	20	30	26	26	31	35
Food, community, and other services (percent)	6	6	10	18	17	7	8
Capital assets (percent)	4	16	3	1	0	0	0
Debt (percent)	6	9	1	0	2	4	0
Total Expenditures (dollars)	128,143,906	31,082,492	2,128,995	1,334,653	3,952,534	4,091,362	2,763,782
End-of-Year Fund Balance (dollars)	31,696,194	11,461,816	688,758	635,061	887,714	1,853,969	745,117

Note: 1993 and 1994 financial audit data is not available for Groom and Highland Park School District. Data presented is for 1992.
Source: PX School 1995b.

TABLE D.2.3–8.—*County and City Revenues and Expenditures for the Los Alamos National Laboratory Region of Influence, 1994*

Revenues and Expenditures	Los Alamos County	Rio Arriba County	Espanola	Santa Fe County	Santa Fe
Property tax (percent)	32	74	11	72	83
State shared and intergovernmental (percent)	61	20	89	12	8
Permits, fees, fines, and investment interest (percent)	1	2	0	6	3
Other (percent)	6	4	0	10	6
Total Revenues (dollars)	29,717,452	10,662,842	6,679,263	29,528,335	65,044,193
General government (percent)	16	36	24	25	18
Public safety, health, and community services (percent)	38	36	37	45	30
Public works, parks, culture, and recreation (percent)	23	23	20	20	16
Debt services (percent)	3	4	12	1	11
Education (percent)	0	0	0	0	3
Capital outlay (percent)	20	1	7	8	22
Other (percent)	0	0	0	1	0
Total Expenditures (dollars)	30,986,489	9,280,844	7,015,513	27,221,324	62,458,448
End-of-Year Fund Balance (dollars)	27,443,804	5,570,366	2,851,826	17,676,743	61,911,387

Source: LA City 1995a; LA County 1995a.

TABLE D.2.3–9.—*School District Revenues and Expenditures for the Los Alamos National Laboratory Region of Influence, 1994*

Revenues and Expenditures	Chama Valley	Dulce	Espanola	Jemez Mountain	Los Alamos	Pojaque Valley	Santa Fe
Local sources (percent)	12	31	6	38	6	8	21
State sources (percent)	77	40	70	50	52	69	71
Federal sources (percent)	10	28	22	11	34	13	6
Other (percent)	1	1	2	1	8	10	2
Total Revenues (dollars)	3,851,965	5,418,941	25,907,153	5,250,028	23,091,825	11,605,168	59,555,031
Total instruction (percent)	43	45	62	35	53	37	41
Support services (percent)	37	36	29	30	39	28	23
Food, community, and other services (percent)	12	5	1	15	6	11	7
Capital assets (percent)	3	6	4	0	2	19	18
Debt services (percent)	5	8	4	20	0	5	11
Total Expenditures (dollars)	3,886,197	4,535,793	25,790,674	4,034,170	21,561,064	10,673,138	66,958,009
End-of-Year Fund Balance (dollars)	824,466	1,960,709	2,729,798	2,061,502	4,511,190	1,958,054	10,345,713

Source: LA School 1995b.

TABLE D.2.3–10.—*County and City Revenues and Expenditures for the Lawrence Livermore National Laboratory Region of Influence, 1994*

Revenues and Expenditures	Alameda County	Livermore	Pleasanton	Contra Costa County	San Joaquin County	Manteca	Tracy
Property tax (percent)	27	52	59	22	15	51	32
State shared and intergovernmental (percent)	54	12	0	57	67	24	16
Permits, fees, fines, and investment interest (percent)	14	17	5	16	16	20	36
Other (percent)	5	19	36	5	2	5	16
Total Revenues (dollars)	1,111,718,000	39,977,156	44,664,303	792,483,000	505,566,121	17,848,109	32,989,112
General government (percent)	6	7	15	9	10	12	7
Public safety, health, and community services (percent)	90	26	32	65	66	44	22
Public works, parks, culture, and recreation (percent)	2	9	23	20	19	25	28
Debt services (percent)	1	10	8	3	4	9	3
Capital outlay (percent)	1	35	21	2	1	2	40
Other (percent)	0	13	1	1	0	8	0
Total Expenditures (dollars)	1,150,106,000	58,087,750	45,191,452	777,803,000	522,340,513	16,405,126	33,796,549
End-of-Year Fund Balance (dollars)	362,808,000	34,291,803	38,104,992	161,995,000	106,530,027	16,254,955	52,444,145

Note: 1993 and 1994 financial audit data are not available for Alameda County. Data presented is for 1992.

Source: LL City 1995a; LL County 1995a.

TABLE D.2.3–9.—*School District Revenues and Expenditures for the Los Alamos National Laboratory Region of Influence, 1994*

Revenues and Expenditures	Chama Valley	Dulce	Espanola	Jemez Mountain	Los Alamos	Pojaque Valley	Santa Fe
Local sources (percent)	12	31	6	38	6	8	21
State sources (percent)	77	40	70	50	52	69	71
Federal sources (percent)	10	28	22	11	34	13	6
Other (percent)	1	1	2	1	8	10	2
Total Revenues (dollars)	3,851,965	5,418,941	25,907,153	5,250,028	23,091,825	11,605,168	59,555,031
Total instruction (percent)	43	45	62	35	53	37	41
Support services (percent)	37	36	29	30	39	28	23
Food, community, and other services (percent)	12	5	1	15	6	11	7
Capital assets (percent)	3	6	4	0	2	19	18
Debt services (percent)	5	8	4	20	0	5	11
Total Expenditures (dollars)	3,886,197	4,535,793	25,790,674	4,034,170	21,561,064	10,673,138	66,958,009
End-of-Year Fund Balance (dollars)	824,466	1,960,709	2,729,798	2,061,502	4,511,190	1,958,054	10,345,713

Source: LA School 1995b.

TABLE D.2.3–10.—*County and City Revenues and Expenditures for the Lawrence Livermore National Laboratory Region of Influence, 1994*

Revenues and Expenditures	Alameda County	Livermore	Pleasanton	Contra Costa County	San Joaquin County	Manteca	Tracy
Property tax (percent)	27	52	59	22	15	51	32
State shared and intergovernmental (percent)	54	12	0	57	67	24	16
Permits, fees, fines, and investment interest (percent)	14	17	5	16	16	20	36
Other (percent)	5	19	36	5	2	5	16
Total Revenues (dollars)	1,111,718,000	39,977,156	44,664,303	792,483,000	505,566,121	17,848,109	32,989,112
General government (percent)	6	7	15	9	10	12	7
Public safety, health, and community services (percent)	90	26	32	65	66	44	22
Public works, parks, culture, and recreation (percent)	2	9	23	20	19	25	28
Debt services (percent)	1	10	8	3	4	9	3
Capital outlay (percent)	1	35	21	2	1	2	40
Other (percent)	0	13	1	1	0	8	0
Total Expenditures (dollars)	1,150,106,000	58,087,750	45,191,452	777,803,000	522,340,513	16,405,126	33,796,549
End-of-Year Fund Balance (dollars)	362,808,000	34,291,803	38,104,992	161,995,000	106,530,027	16,254,955	52,444,145

Note: 1993 and 1994 financial audit data are not available for Alameda County. Data presented is for 1992.

Source: LL City 1995a; LL County 1995a.

TABLE D.2.3–11.—*School District Revenues and Expenditures for the Lawrence Livermore National Laboratory Region of Influence, 1994*

Revenues and Expenditures	Livermore	Manteca	Pleasanton	Tracy
Local sources (percent)	25	NA	43	54
State sources (percent)	18	NA	2	3
Federal sources (percent)	4	NA	16	21
Other (percent)	53	NA	39	22
Total Revenues (dollars)	45,153,012	NA	41,647,514	10,492,709
Total instruction (percent)	61	NA	64	67
Support services (percent)	10	NA	9	10
Food, community, and other services (percent)	15	NA	6	6
Capital assets (percent)	12	NA	13	14
Debt services (percent)	2	NA	8	3
Total Expenditures (dollars)	61,710,651	NA	62,763,588	17,080,415
End-of-Year Fund Balance (dollars)	20,793,153	NA	47,224,057	2,989,001

Note: NA - not available.
Source: LL School 1995b.

TABLE D.2.3–12.—*County and City Revenues and Expenditures for the Sandia National Laboratories Region of Influence, 1994*

Revenues and Expenditures	Bernalillo County	Albuquerque	Sandoval County	Valencia County
Property tax (percent)	55	39	28	53
State shared and intergovernmental (percent)	34	42	40	22
Permits, fees, fines, and investment interest (percent)	5	12	23	8
Other (percent)	6	7	9	17
Total Revenues (dollars)	93,822,427	385,722,000	16,098,094	8,637,085
General government (percent)	33	10	21	47
Public safety, health, and community services (percent)	31	38	51	39
Public works, parks, culture, and recreation (percent)	11	18	21	14
Debt services (percent)	9	15	3	0
Education (percent)	0	0	0	0
Capital outlay (percent)	16	19	4	0
Other (percent)	0	0	0	0
Total Expenditures (dollars)	104,033,393	402,203,000	15,833,145	7,891,026
End-of-Year Fund Balance (dollars)	100,227,840	165,534,000	8,984,259	3,858,325

Source: SN City 1995m; SN County 1995n.

TABLE D.2.3–13.—*School District Revenues and Expenditures for the Sandia National Laboratories Region of Influence, 1994*

Revenues and Expenditures	Albuquerque	Belen	Bernalillo	Cuba	Jemez Valley	Los Lunas
Local sources (percent)	15	12	9	7	10	9
State sources (percent)	77	78	68	68	84	82
Federal sources (percent)	8	10	22	23	6	9
Other (percent)	0	0	1	2	0	0
Total Revenues (dollars)	440,575,033	20,666,616	18,255,208	5,607,902	15,271,490	29,715,373
Total instruction (percent)	70	60	44	35	27	55
Support services (percent)	11	19	30	39	18	15
Food, community, and other services (percent)	7	11	9	17	7	10
Capital assets (percent)	9	4	12	6	10	15
Debt services (percent)	3	6	5	3	38	5
Total Expenditures (dollars)	431,378,717	21,036,713	19,110,291	5,585,793	15,989,616	30,399,901
End-of-Year Fund Balance (dollars)	65,734,673	6,535,537	1,507,421	350,155	727,740	6,925,651

Source: SN School 1995b.

TABLE D.2.3–14.—*County and City Revenues and Expenditures for the Nevada Test Site Region of Influence, 1994*

Revenues and Expenditures	Clark County	Henderson	Las Vegas	North Las Vegas	Nye County
Property tax (percent)	20	16	16	15	28
State shared and intergovernmental (percent)	42	47	54	54	54
Permits, fees, fines, and investment interest (percent)	30	12	19	25	8
Other (percent)	8	25	11	6	10
Total Revenues (dollars)	728,952,912	70,207,217	254,132,758	52,451,349	26,331,990
General government (percent)	19	11	16	11	29
Public safety, health, and community services (percent)	39	25	40	52	37
Public works, parks, culture, and recreation (percent)	8	10	16	15	18
Debt services (percent)	8	13	4	5	0
Capital outlay (percent)	22	41	24	17	16
Other (percent)	4	0	0	0	0
Total Expenditures (dollars)	768,785,508	90,878,941	257,883,768	54,111,779	26,150,708
End-of-Year Fund Balance (dollars)	809,371,503	131,125,991	165,467,135	13,390,894	16,984,705

Note: 1994 financial audit for Clark County was not available. Data presented are for 1993.
Source: NT City 1995a; NT County 1995b.

TABLE D.2.3–15.—*School District Revenues and Expenditures for the Nevada Test Site Region of Influence, 1994*

Revenues and Expenditures	Clark County	Nye County
Local sources (percent)	65	53
State sources (percent)	32	44
Federal sources (percent)	3	3
Other (percent)	0	0
Total Revenues (dollars)	716,416,150	24,079,470
Total instruction (percent)	54	48
Support services (percent)	28	21
Food, community, and other services (percent)	0	6
Capital assets (percent)	11	9
Debt services (percent)	7	16
Total Expenditures (dollars)	776,079,680	25,176,765
End-of-Year Fund Balance (dollars)	82,578,235	5,060,909

Source: NT School 1995b.

D.2.4 Environmental Justice in Minority and Low-Income Populations

DOE is committed, and required by law, to incorporate environmental justice principles into its operations. Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low Income Populations*, requires Federal agencies to identify and address appropriately disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority and low-income populations. DOE is in the process of finalizing its Environmental Justice Strategy and issued its first document in April 1995, which provides a structured framework. This strategy will be finalized once stakeholders' comments, concerns, and opinions are received, reviewed, and incorporated as appropriate. Because DOE is still in the process of developing guidance, the approach taken in this analysis may depart somewhat from the guidance that is eventually issued.

Any disproportionately high and adverse human health effects on minority populations and low-income populations that could result from the alternatives being considered are assessed for an 80 km (50 mi) area surrounding each site. The shaded areas in figures D.2.4–1 through D.2.4–8 show Census tracts where racial or ethnic minorities comprise 50 percent or more (simple majority) of the total population, and where racial or ethnic minorities comprise less than 50 but greater than 25 percent of the total population in the Census tract. Figures D.2.4–9 through D.2.4–16 show low income communities generally defined as those where 25 percent or more of the population is characterized as living in poverty (income of less than $8,076 for a family of two). Socioeconomic impacts are assessed for the ROI of each site, since the impacts result from economic linkages rather than geographic proximity. Selected demographic characteristics of the ROI for each of the seven candidates sites are presented in tables D.2.4–1 through D.2.4–8. An assessment of any potential disproportionately high and adverse human health or environmental effects on minority and low-income populations that could result from the alternatives being considered is presented in chapter 4.

TABLE D.2.4–1.—*Selected Demographic Characteristics for the Oak Ridge Reservation Region of Influence*

Characteristic/Area	Anderson County (number)	Knox County (number)	Loudon County (number)	Roane County (number)	Total Region of Influence (number)	Total Region of Influence (percent)
Persons by Race/Ethnicity						
Non-Hispanic, White	64,320	300,040	30,668	45,274	440,302	91.3
Hispanic	381	2,067	83	212	2,743	0.6
Non-Hispanic, American Indian	236	775	52	95	1,158	0.2
Non-Hispanic, Black	2,753	29,483	400	1,456	34,092	7.1
Non-Hispanic, Asian/Pacific Islander	537	3,263	49	186	4,035	0.8
Non-Hispanic, Other	23	121	3	4	151	0.0
Total 1990 Population	68,250	335,749	31,255	47,227	482,481	
Total Number of Households	27,384	133,639	12,155	18,453	191,631	
1989 Low Income						
Persons Below Poverty						
Number	9,664	45,608	4,192	7,467	66,931	
Percent[a]	14.3	14.1	13.6	16.0	14.3	

[a] In calculating percentages, certain categories of individuals are not included as part of the county population including: inmates of institutions, armed forces members, and unrelated individuals under 15 years of age.

Source: Census 1993s; Census 1994o.

TABLE D.2.4–2.—*Selected Demographic Characteristics for the Savannah River Site Region of Influence*

Characteristic/Area	South Carolina		Georgia		Total Region of Influence	
	Aiken County (number)	Barnwell County (number)	Columbia County (number)	Richmond County (number)	(number)	(percent)
Persons by Race/Ethnicity						
Non-Hispanic, White	90,130	11,421	56,141	103,009	270,727	63.6
Hispanic	867	146	962	3,707	5,918	1.4
Non-Hispanic, American Indian	213	31	150	491	918	0.2
Non-Hispanic, Black	29,176	8,677	7,239	79,221	142,608	33.5
Non-Hispanic, Asian/Pacific Islander	528	17	1,518	3,186	5,276	1.2
Non-Hispanic, Other	26	1	21	105	160	0.0
Total 1990 Population	120,940	20,293	66,031	189,719	425,607	99.9
Total Number of Households	44,883	7,100	21,841	68,675	151,877	
1989 Low Income						
Persons Below Poverty						
Number	16,671	4,367	4,255	32,590	66,267	
Percent[a]	14.0	21.8	6.6	18.2	17.3	

[a] In calculating percentages, certain categories of individuals are not included as part of the county population including: inmates of institutions, armed forces members, and unrelated individuals under 15 years of age.

Source: Census 1993s; Census 1994o.

TABLE D.2.4–3.—*Selected Demographic Characteristics for the Kansas City Plant Region of Influence*

Characteristic/Area	Missouri		Kansas		Total Region of Influence	
	Cass County (number)	Jackson County (number)	Johnson County (number)	Wyandotte County (number)	(number)	(percent)
Persons by Race/Ethnicity						
Non-Hispanic, White	61,689	470,011	334,167	103,955	969,822	79.9
Hispanic	829	18,890	7,005	10,997	37,721	3.1
Non-Hispanic, American Indian	355	2,825	160	966	4,306	0.4
Non-Hispanic, Black	672	134,828	6,809	44,131	186,440	15.4
Non-Hispanic, Asian/Pacific Islander	251	6,145	5,739	787	12,922	1.1
Non-Hispanic, Other	12	533	174	157	876	0.1
Total 1990 Population	63,808	633,232	355,054	161,993	1,214,087	100
Total Number of Households	22,892	252,852	136,433	61,514	473,691	
1989 Low Income						
Persons Below Poverty						
Number	5,164	81,142	12,667	27,371	126,344	
Percent[a]	8.2	13.0	3.6	17.1	10.5	

[a] In calculating percentages, certain categories of individuals are not included as part of the county population including: inmates of institutions, armed forces members, and unrelated individuals under 15 years of age.

Source: Census 1993s; Census 1994o.

TABLE D.2.4–4.—*Selected Demographic Characteristics for the Pantex Plant Region of Influence*

Characteristic/Area	Armstrong County (number)	Carson County (number)	Potter County (number)	Randall County (number)	Total Region of Influence (number)	Total Region of Influence (percent)
Persons by Race/Ethnicity						
Non-Hispanic, White	1,951	6,158	66,877	81,364	156,350	79.7
Hispanic	55	354	19,246	6,144	25,799	13.1
Non-Hispanic, American Indian	9	41	709	414	1,173	0.6
Non-Hispanic, Black	0	11	8,460	1,082	9,553	4.9
Non-Hispanic, Asian/Pacific Islander	5	9	2,431	626	3,071	1.6
Non-Hispanic, Other	1	3	151	43	198	0.1
Total 1990 Population	2,021	6,576	97,874	89,673	196,144	100.0
Total Number of Households	768	2,402	37,344	34,553	75,067	
1989 Low Income						
Persons Below Poverty						
Number	232	583	21,619	7,819	30,253	
Percent[a]	11.8	9.0	22.5	8.9	15.7	

[a] In calculating percentages, certain categories of individuals are not included as part of the county population including: inmates of institutions, armed forces members, and unrelated individuals under 15 years of age.

Source: Census 1993s; Census 1994o.

TABLE D.2.4–5.—*Selected Demographic Characteristics for the Los Alamos National Laboratory Region of Influence*

Characteristic/Area	Los Alamos County (number)	Rio Arriba County (number)	Santa Fe County (number)	Total Region of Influence (number)	Total Region of Influence (percent)
Persons by Race/Ethnicity					
Non-Hispanic, White	15,467	4,375	46,450	66,292	43.8
Hispanic	2,008	24,955	48,939	75,902	50.1
Non-Hispanic, American Indian	112	4,830	2,284	7,226	4.8
Non-Hispanic, Black	88	117	505	710	0.5
Non-Hispanic, Asian/Pacific Islander	421	40	439	900	0.6
Non-Hispanic, Other	19	48	311	378	0.2
Total 1990 Population	18,115	34,365	98,928	151,408	100
Total Number of Households	7,213	11,461	37,840	56,514	
1989 Low Income					
Persons Below Poverty					
Number	433	9,372	12,564	22,369	
Percent[a]	2.4	27.5	13	15.0	

[a] In calculating percentages, certain categories of individuals are not included as part of the county population including: inmates of institutions, armed forces members, and unrelated individuals under 15 years of age.

Source: Census 1993s; Census 1994o.

TABLE D.2.4–6.—*Selected Demographic Characteristics for the Lawrence Livermore National Laboratory Region of Influence*

Characteristic/Area	Alameda County (number)	Contra Costa County (number)	San Joaquin County (number)	Total Region of Influence (number)	Total Region of Influence (percent)
Persons by Race/Ethnicity					
Non-Hispanic, White	680,017	560,146	282,766	1,522,929	59.4
Hispanic	181,805	91,282	112,673	385,760	15
Non-Hispanic, American Indian	6,763	4,441	3,807	15,011	0.6
Non-Hispanic, Black	222,873	72,799	24,791	320,463	12.5
Non-Hispanic, Asian/Pacific Islander	184,813	73,810	55,774	314,397	12.3
Non-Hispanic, Other	2,911	1,254	817	4,982	0.2
Total 1990 Population	1,279,182	803,732	480,628	2,563,542	100
Total Number of Households	479,518	300,288	158,156	937,962	
1989 Low Income					
Persons Below Poverty					
Number	132,011	57,867	73,163	263,041	
Percent[a]	10.6	7.3	15.7	10.5	

[a] In calculating percentages, certain categories of individuals are not included as part of the county population including: inmates of institutions, armed forces members, and unrelated individuals under 15 years of age.

Source: Census 1993s; Census 1994o.

TABLE D.2.4–7.—*Selected Demographic Characteristics for the Sandia National Laboratories Region of Influence*

Characteristic/Area	Bernalillo County (number)	Sandoval County (number)	Valencia County (number)	Total Region of Influence (number)	Total Region of Influence (percent)
Persons by Race/Ethnicity					
Non-Hispanic, White	267,965	32,390	20,659	321,014	54.5
Hispanic	178,310	17,372	22,733	218,415	37.1
Non-Hispanic, American Indian	14,191	12,176	1,169	27,536	4.7
Non-Hispanic, Black	11,862	844	448	13,154	2.2
Non-Hispanic, Asian/Pacific Islander	6,692	455	139	7,286	1.2
Non-Hispanic, Other	1,557	82	87	1,726	0.3
Total 1990 Population	480,577	63,319	45,235	589,131	100
Total Number of Households	185,582	20,867	15,170	221,619	
1989 Low Income					
Persons Below Poverty					
Number	68,845	9,852	8,288	86,985	
Percent[a]	14.6	15.6	19	15.0	

[a] In calculating percentages, certain categories of individuals are not included as part of the county population including: inmates of institutions, armed forces members, and unrelated individuals under 15 years of age.

Source: Census 1993s; Census 1994o.

TABLE D.2.4–8.—*Selected Demographic Characteristics for the Nevada Test Site Region of Influence*

Characteristic/Area	Clark County (number)	Nye County (number)	Total Region of Influence (number)	Total Region of Influence (percent)
Persons by Race/Ethnicity				
Non-Hispanic, White	558,875	15,635	574,510	75.7
Hispanic	82,904	1,237	84,141	11.1
Non-Hispanic, American Indian	5,514	475	5,989	0.8
Non-Hispanic, Black	68,858	274	69,132	9.1
Non-Hispanic, Asian/Pacific Islander	24,483	148	24,631	3.2
Non-Hispanic, Other	825	12	837	0.1
Total 1990 Population	741,459	17,781	759,240	100.0
Total Number of Households	287,025	6,664	293,689	
1989 Low Income				
Persons Below Poverty				
Number	76,737	1,840	78,577	
Percent[a]	10.5	10.5	10.5	

[a] In calculating percentages, certain categories of individuals are not included as part of the county population including: inmates of institutions, armed forces members, and unrelated individuals under 15 years of age.

Source: Census 1993s; Census 1994o.

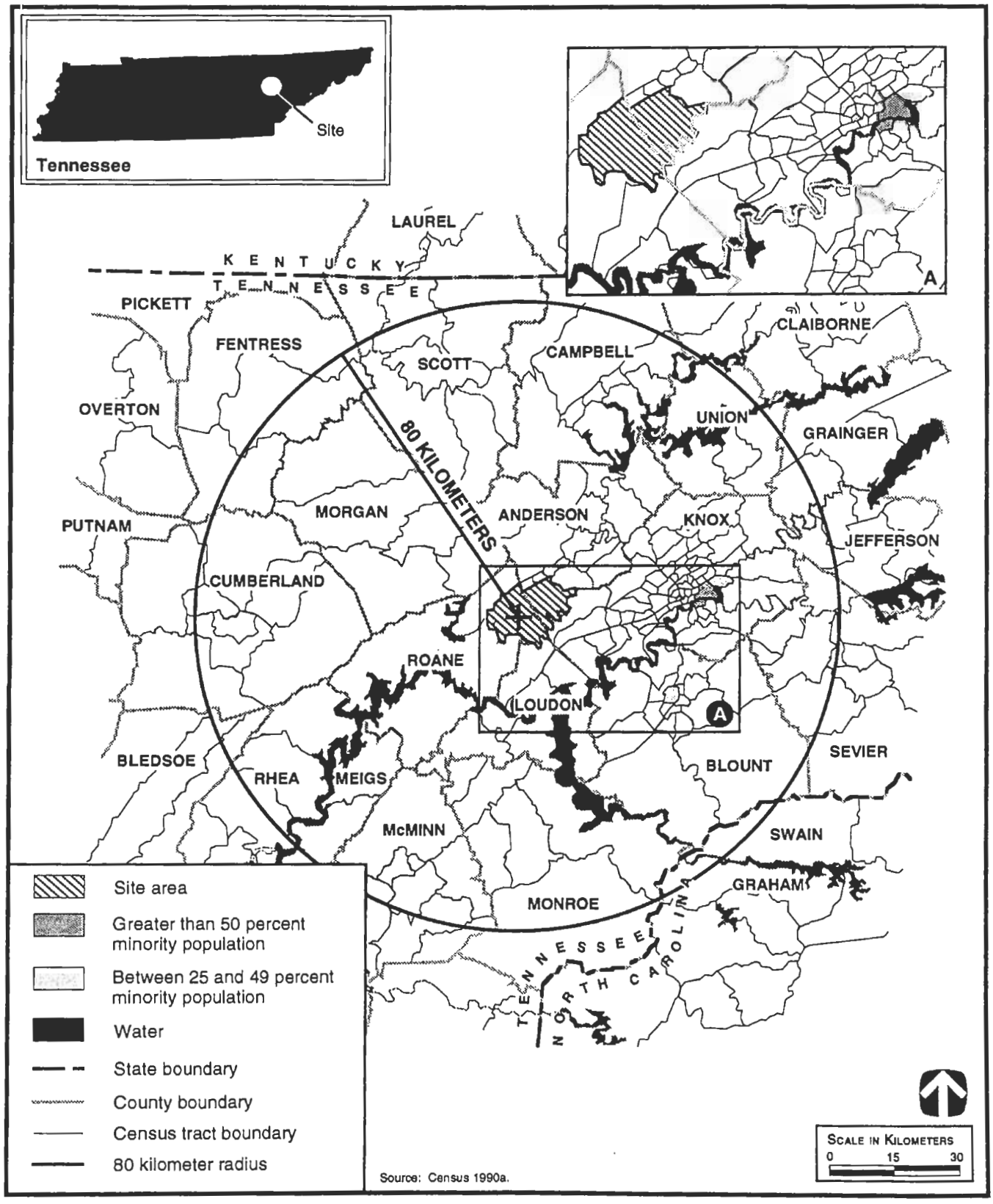


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FIGURE D.2.4–1.—*Minority Population Distribution for Oak Ridge Reservation and Surrounding Area.*

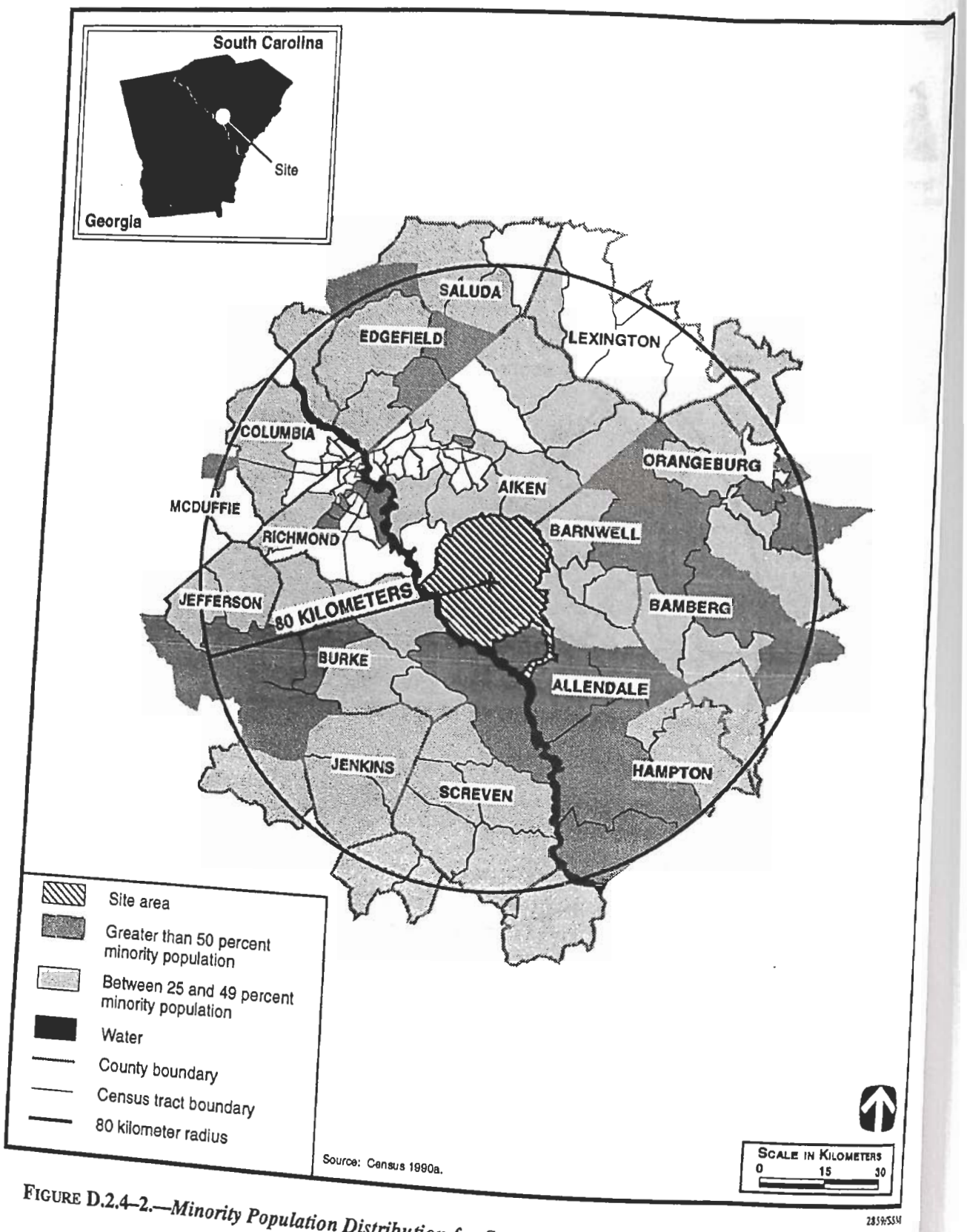


FIGURE D.2.4–2.—*Minority Population Distribution for Savannah River Site and Surrounding Area.*

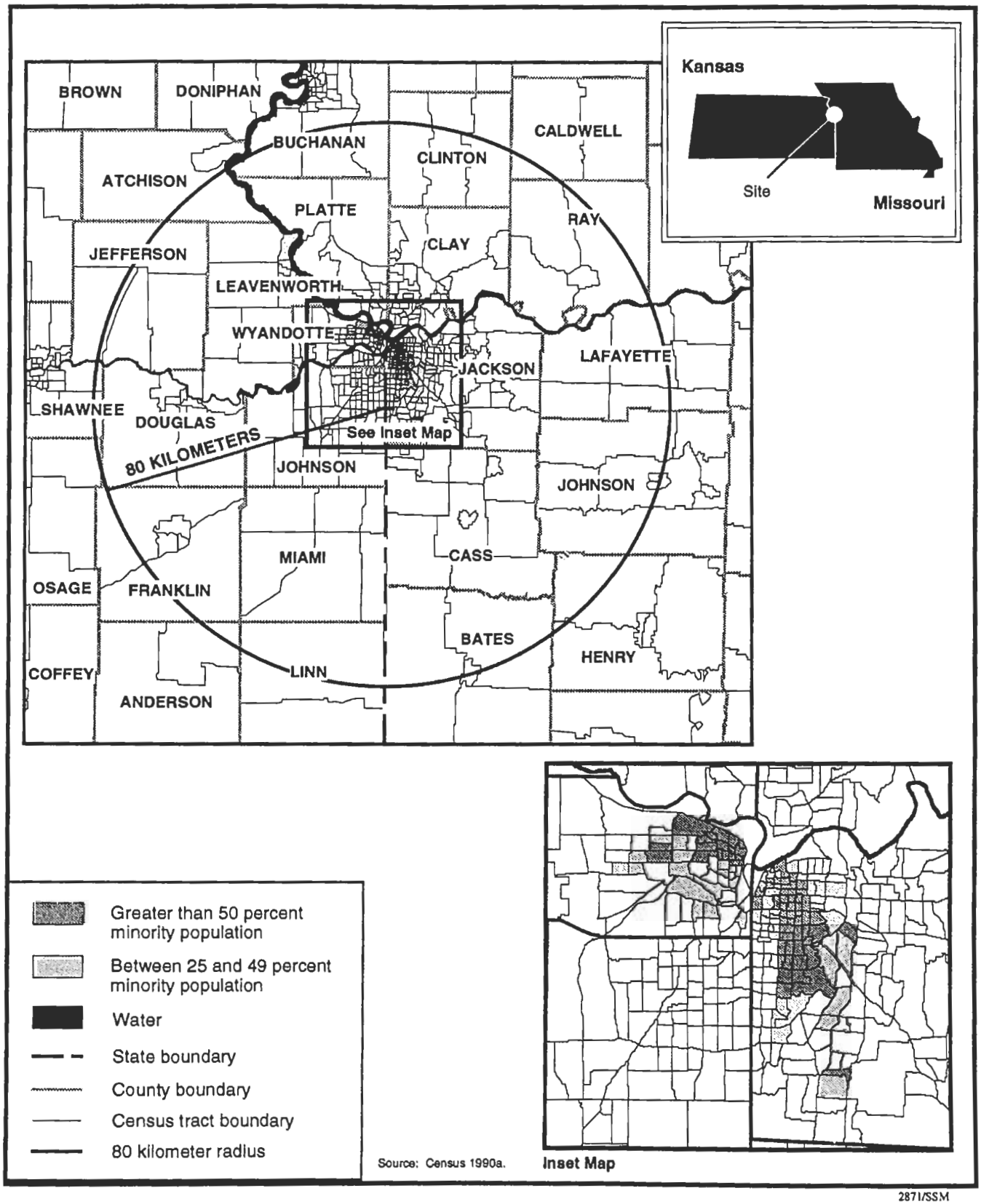


FIGURE D.2.4–3.—*Minority Population Distribution for Kansas City Plant and Surrounding Area.*

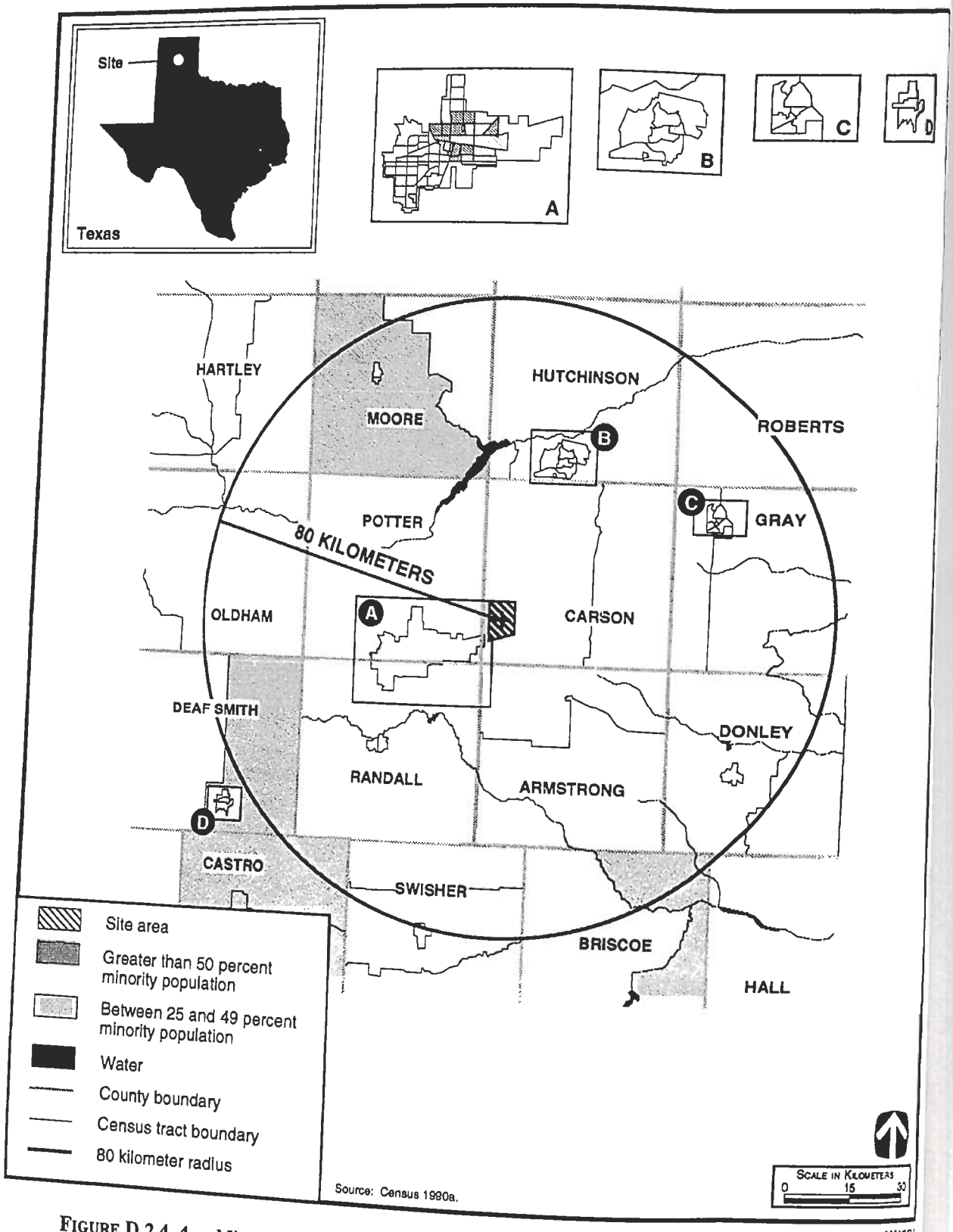


FIGURE D.2.4-4.—*Minority Population Distribution for Pantex Plant and Surrounding Area.*

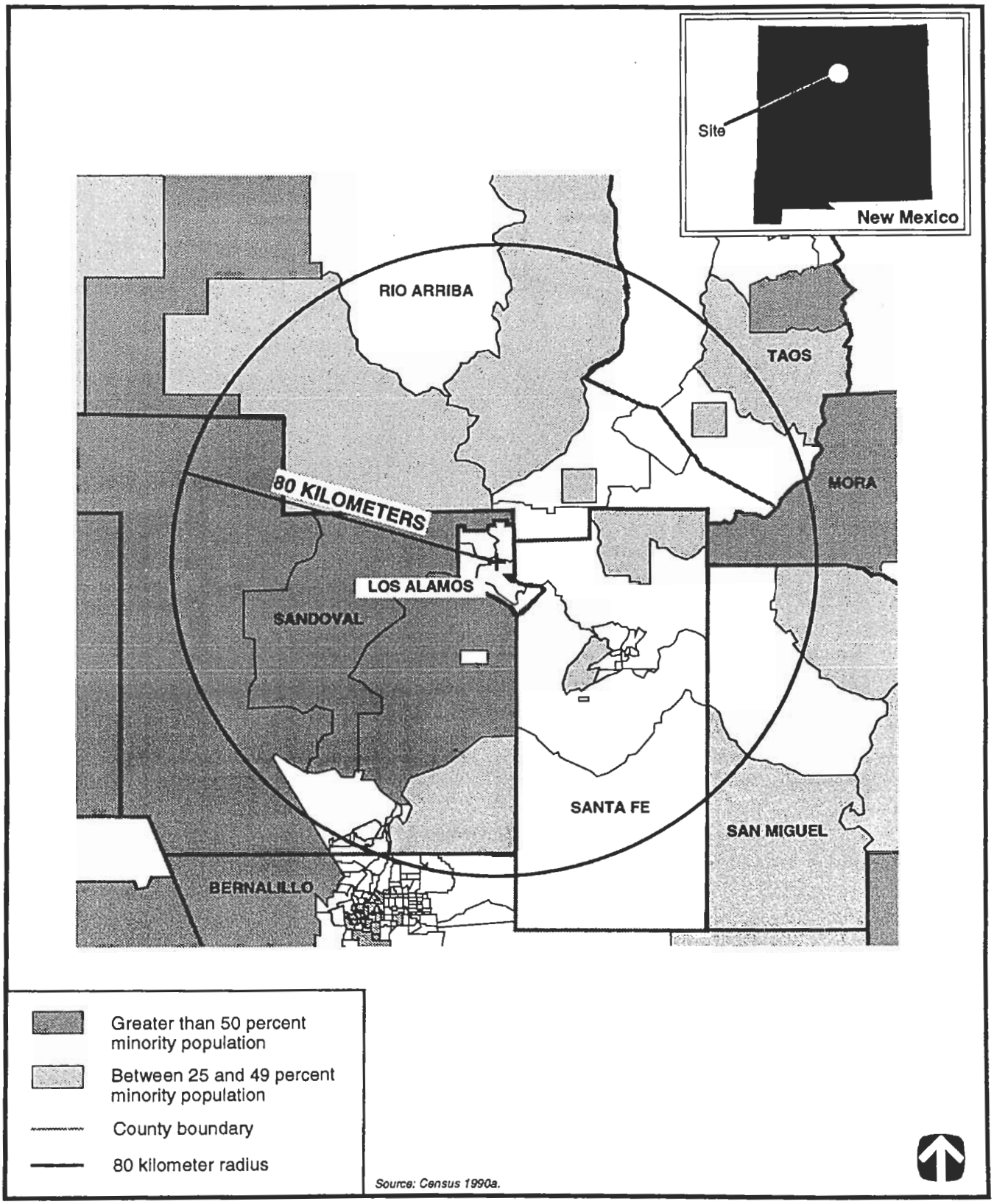


FIGURE D.2.4–5.—*Minority Population Distribution for Los Alamos National Laboratory and Surrounding Area.*

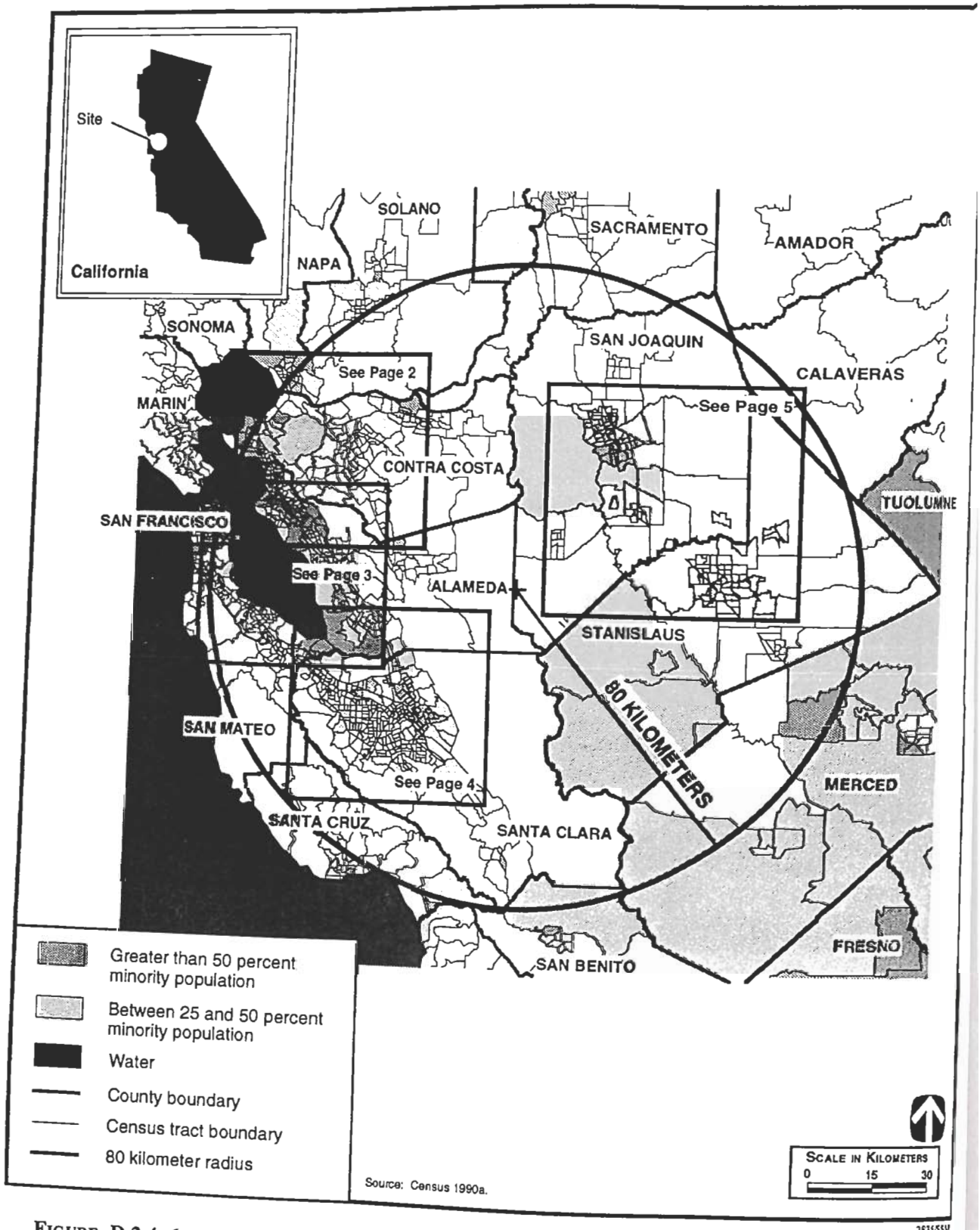


FIGURE D.2.4–6.—*Minority Population Distribution for Lawrence Livermore National Laboratory and Surrounding Area* [Page 1 of 5].

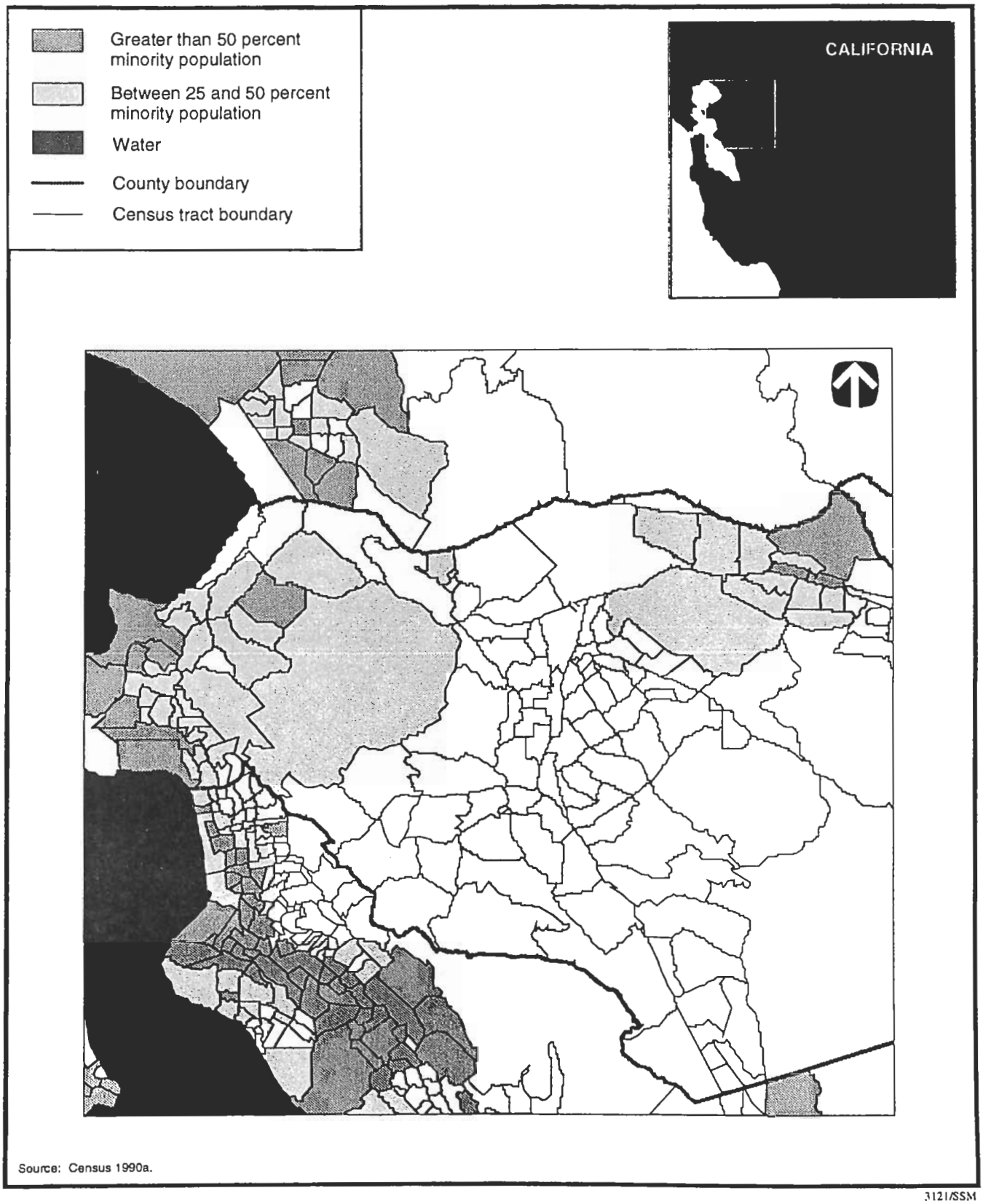


FIGURE D.2.4–6.—*Minority Population Distribution for Lawrence Livermore National Laboratory and Surrounding Area* **[Page 2 of 5].**

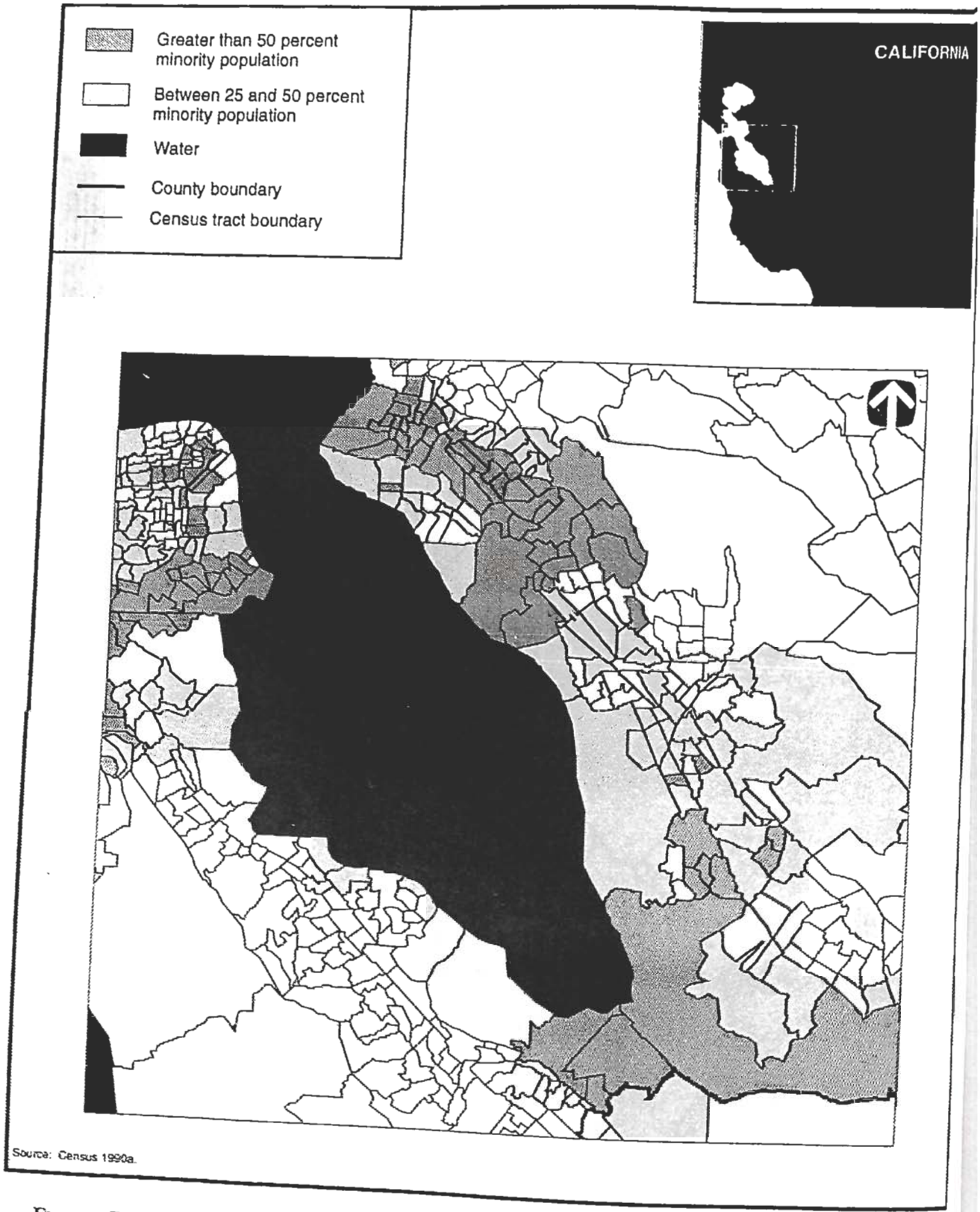


FIGURE D.2.4–6.—*Minority Population Distribution for Lawrence Livermore National Laboratory and Surrounding Area* [Page 3 of 5].

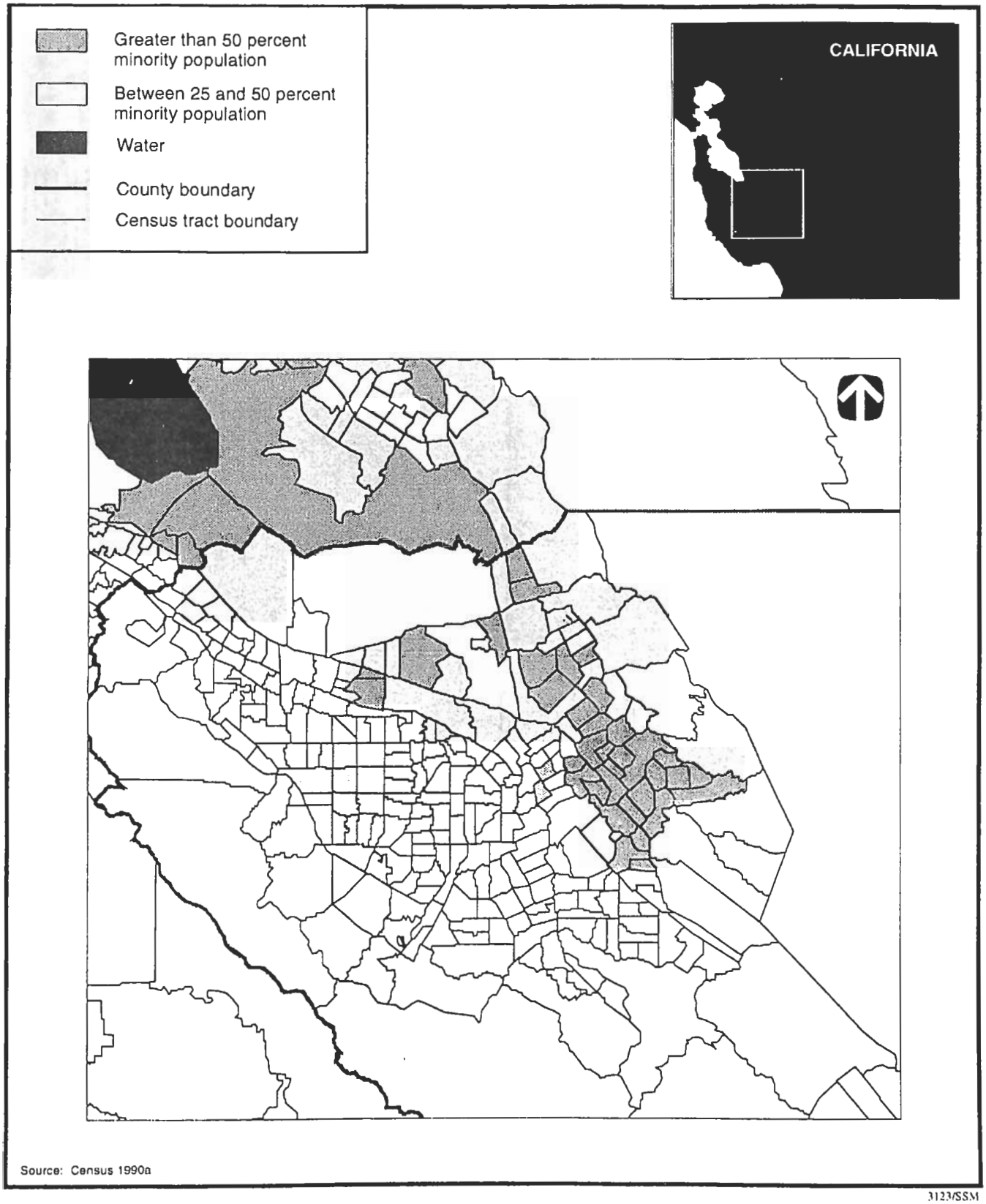


FIGURE D.2.4–6.—*Minority Population Distribution for Lawrence Livermore National Laboratory and Surrounding Area* [Page 4 of 5].

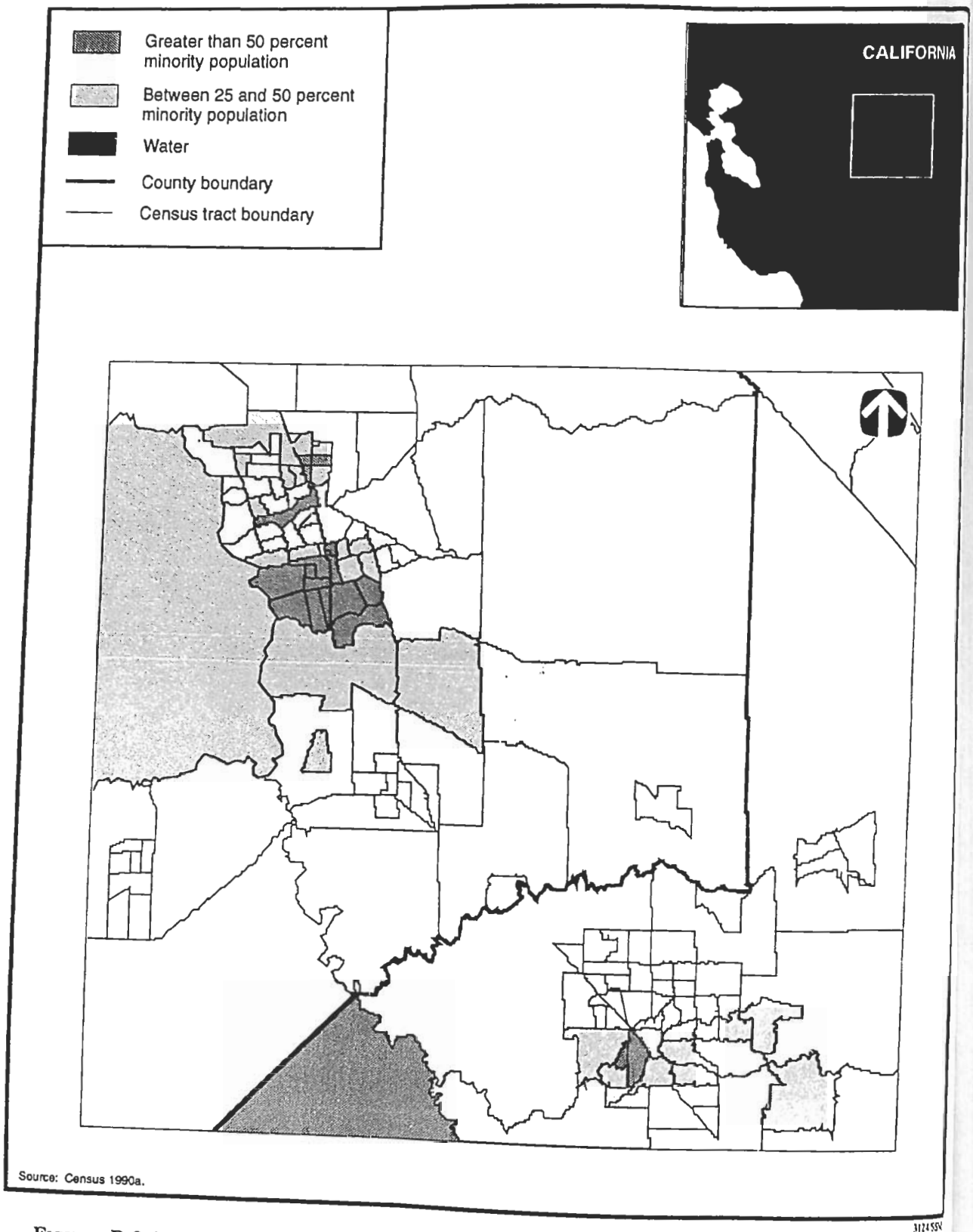


FIGURE D.2.4–6.—*Minority Population Distribution for Lawrence Livermore National Laboratory and Surrounding Area* [Page 5 of 5].

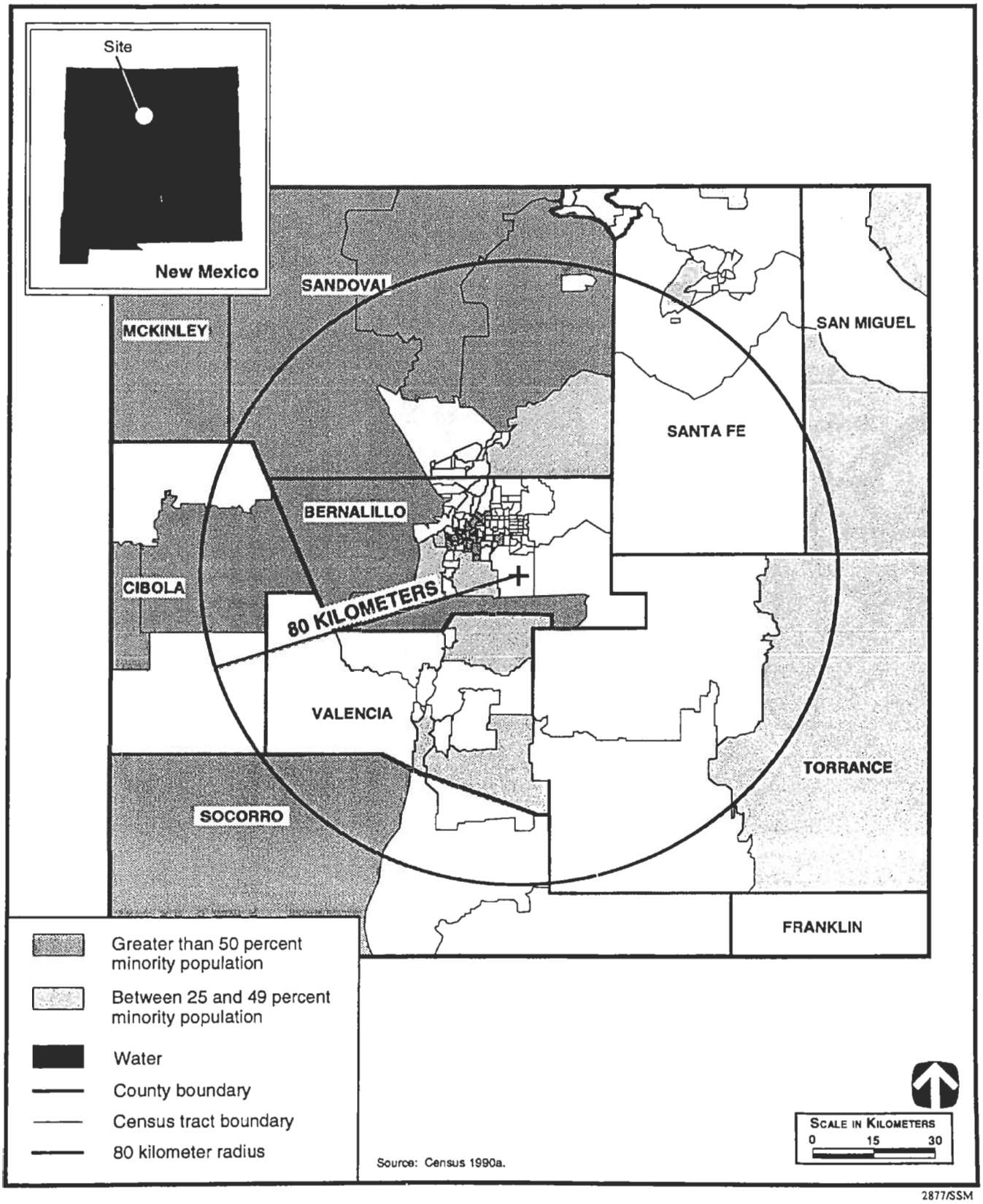


FIGURE D.2.4–7.—*Minority Population Distribution for Sandia National Laboratories and Surrounding Area.*

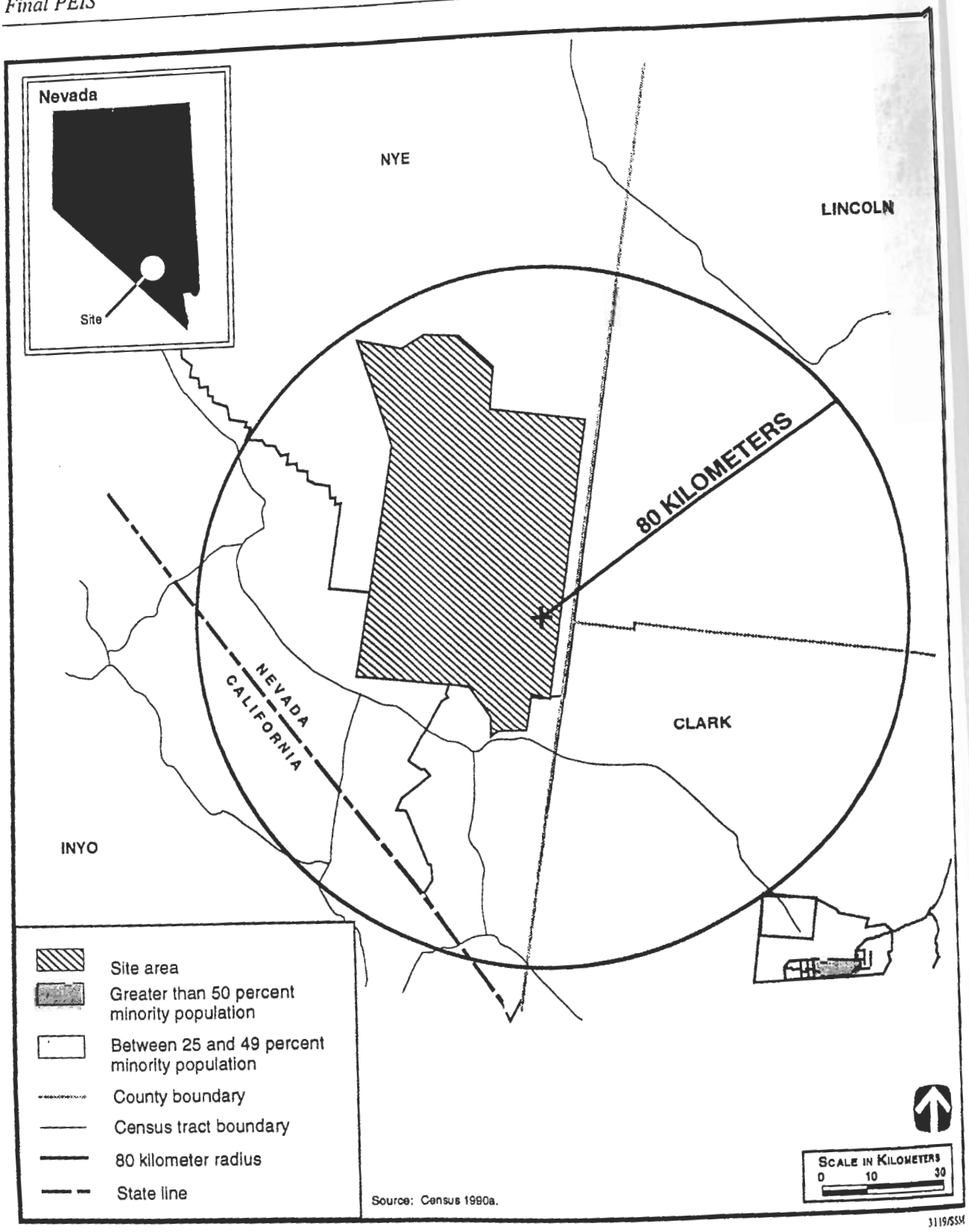


FIGURE D.2.4–8.—*Minority Population Distribution for Nevada Test Site and Surrounding Area.*

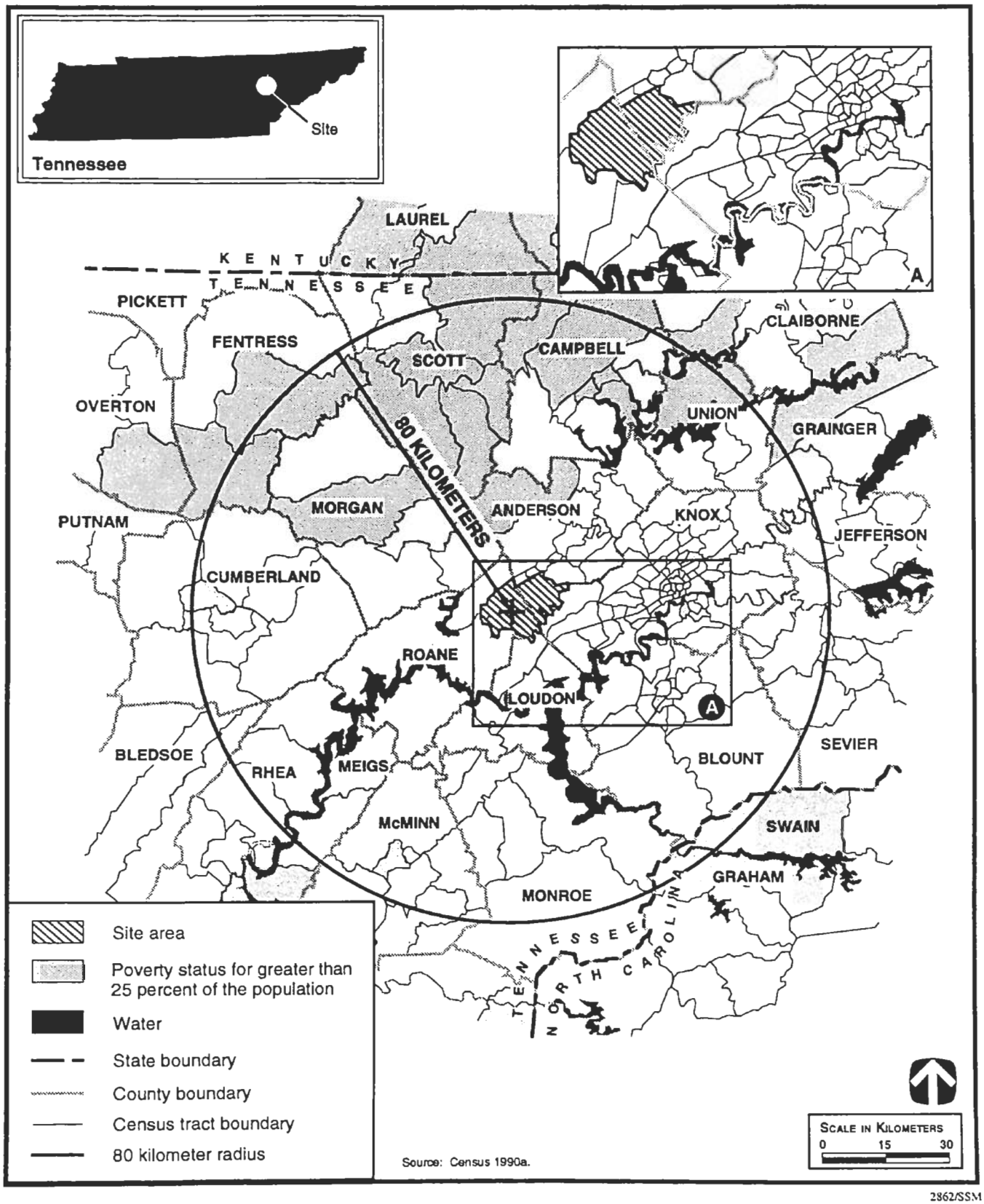


FIGURE D.2.4–9.—***Low-Income Population Distribution by Poverty Status for Oak Ridge Reservation and Surrounding Area.***

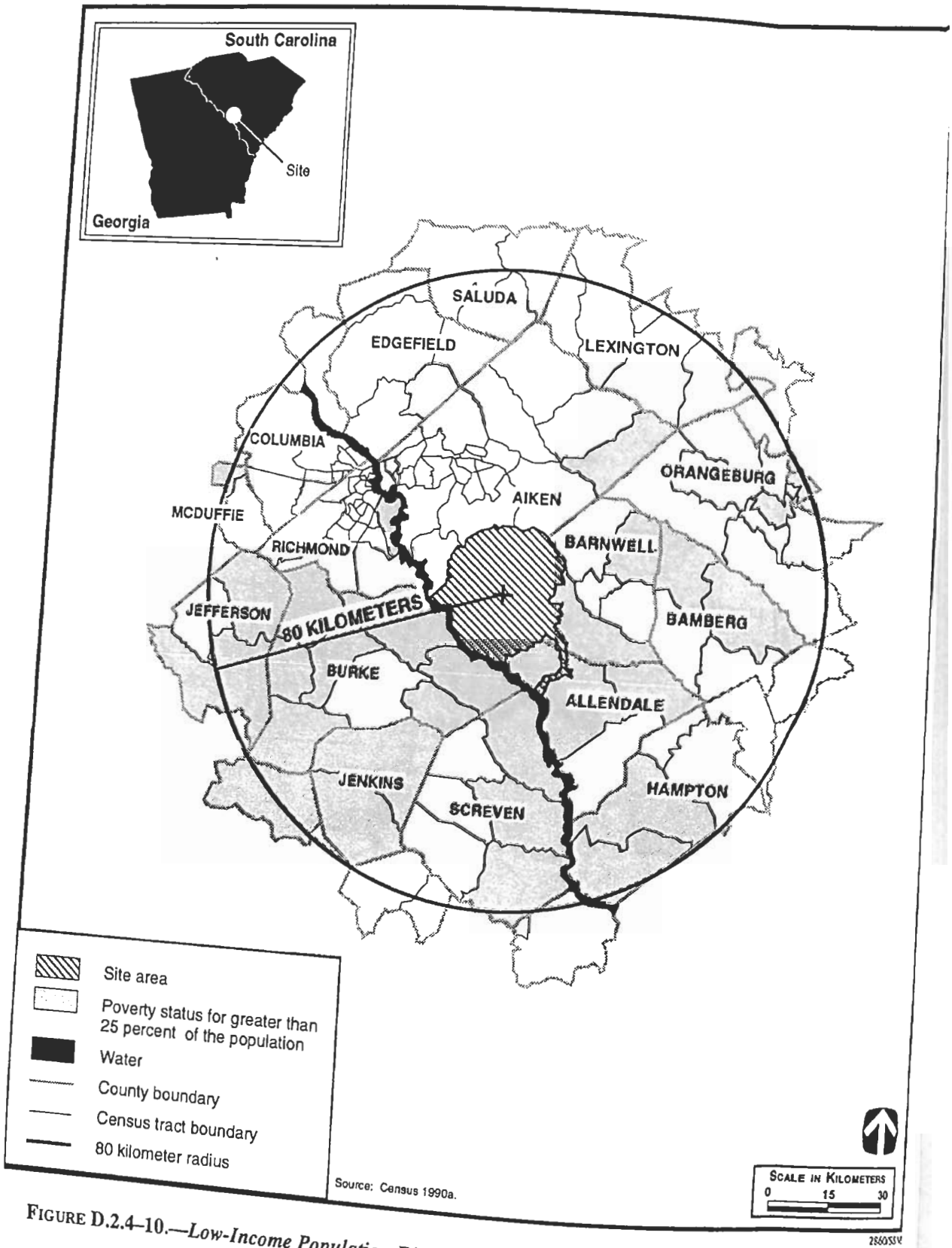


FIGURE D.2.4–10.—*Low-Income Population Distribution by Poverty Status for Savannah River Site and Surrounding Area.*

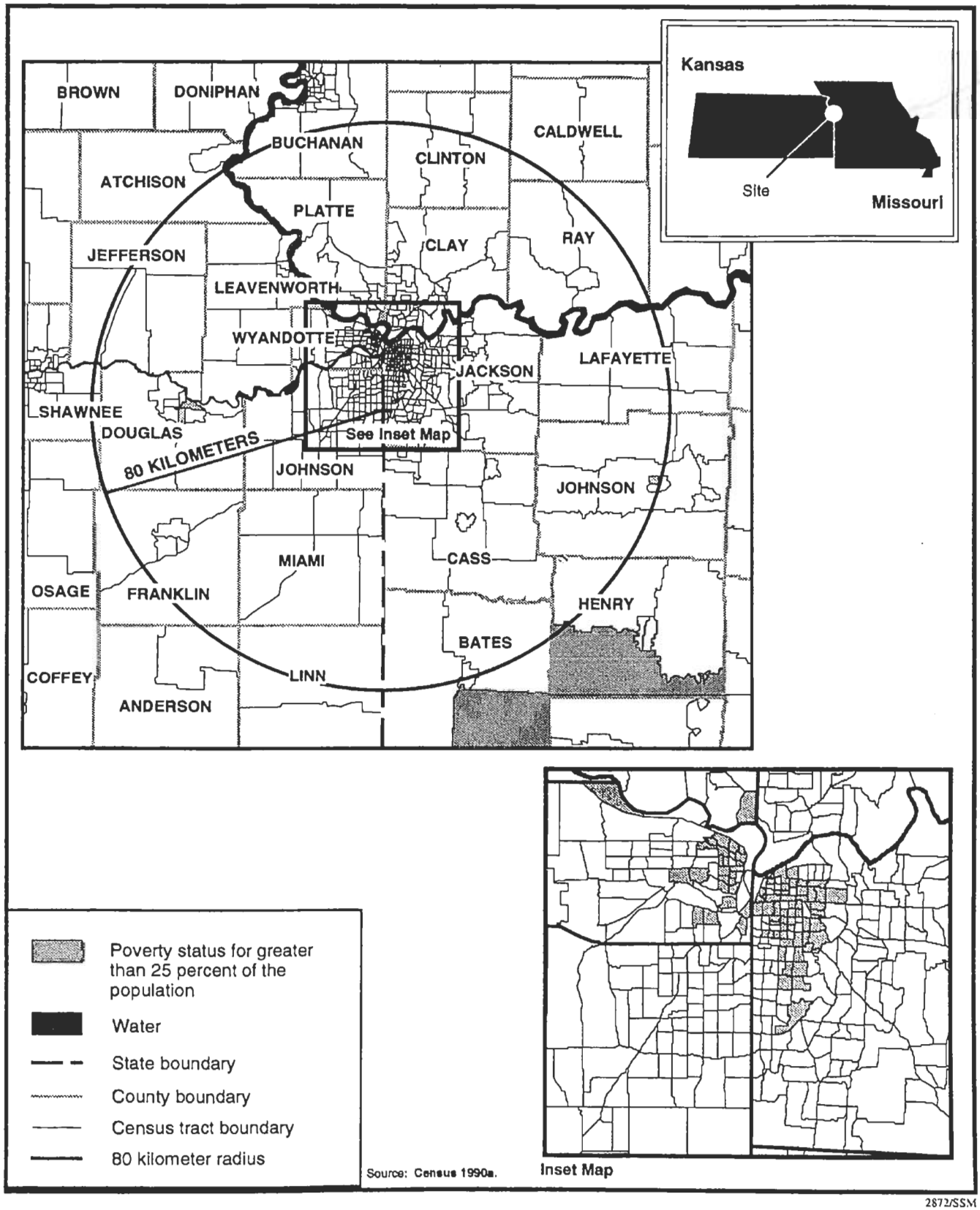


FIGURE D.2.4–11.—*Low-Income Population Distribution by Poverty Status for Kansas City Plant and Surrounding Area.*

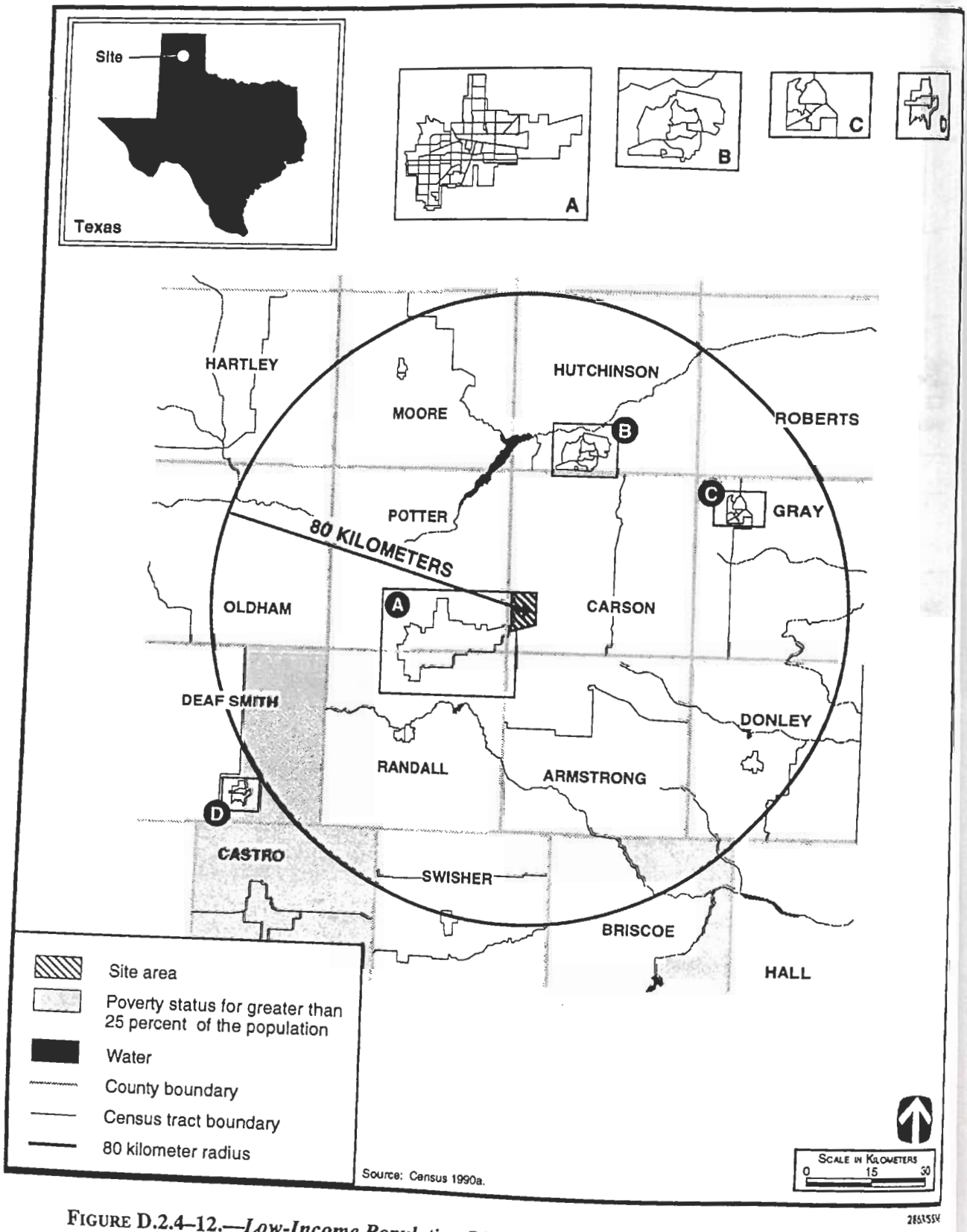


FIGURE D.2.4–12.—*Low-Income Population Distribution by Poverty Status for Pantex Plant and Surrounding Area.*

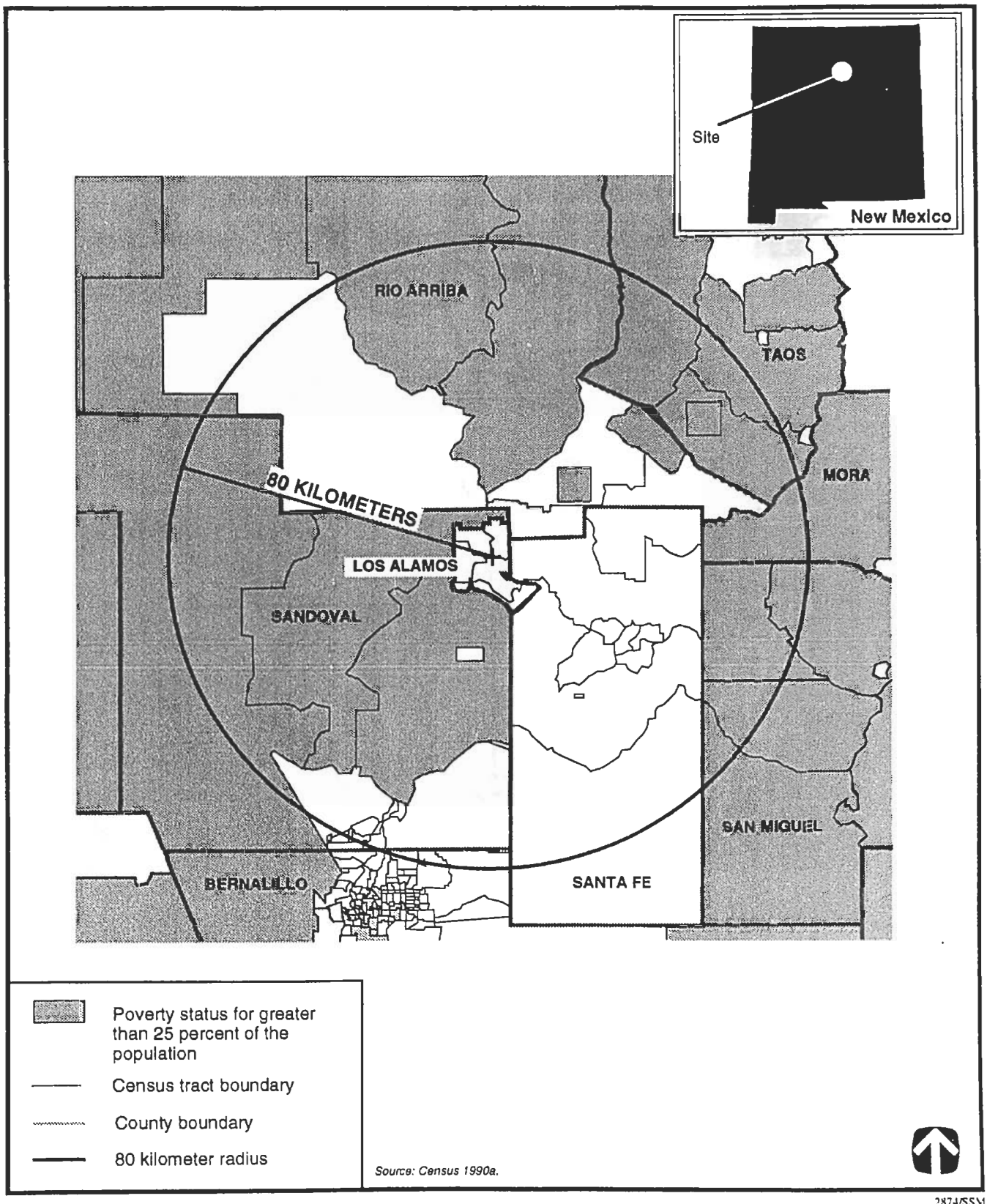


FIGURE D.2.4–13.—*Low-Income Population Distribution by Poverty Status for Los Alamos National Laboratory and Surrounding Area.*

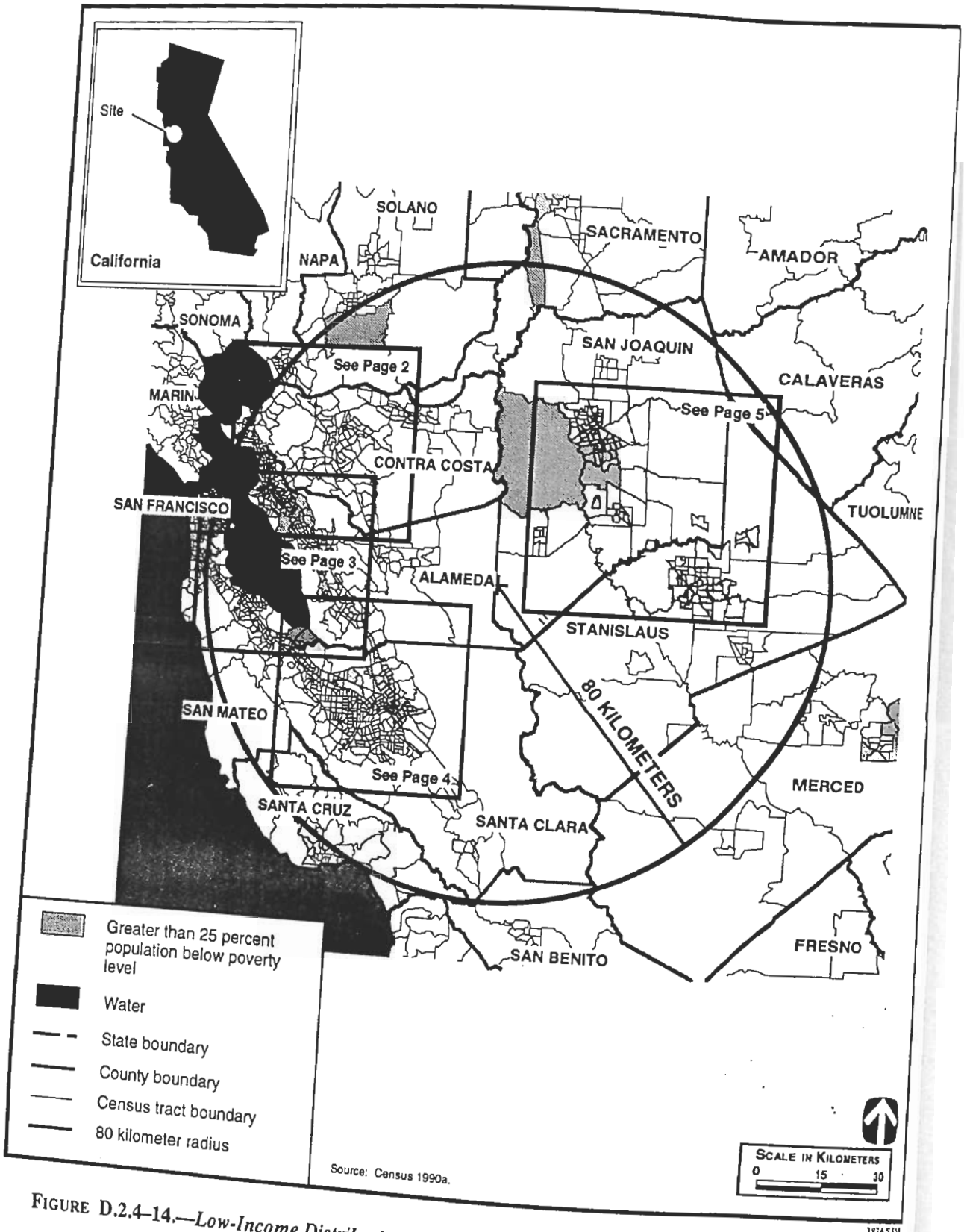


FIGURE D.2.4–14.—*Low-Income Distribution by Poverty Status for Lawrence Livermore National Laboratory and Surrounding Area* [Page 1 of 5].

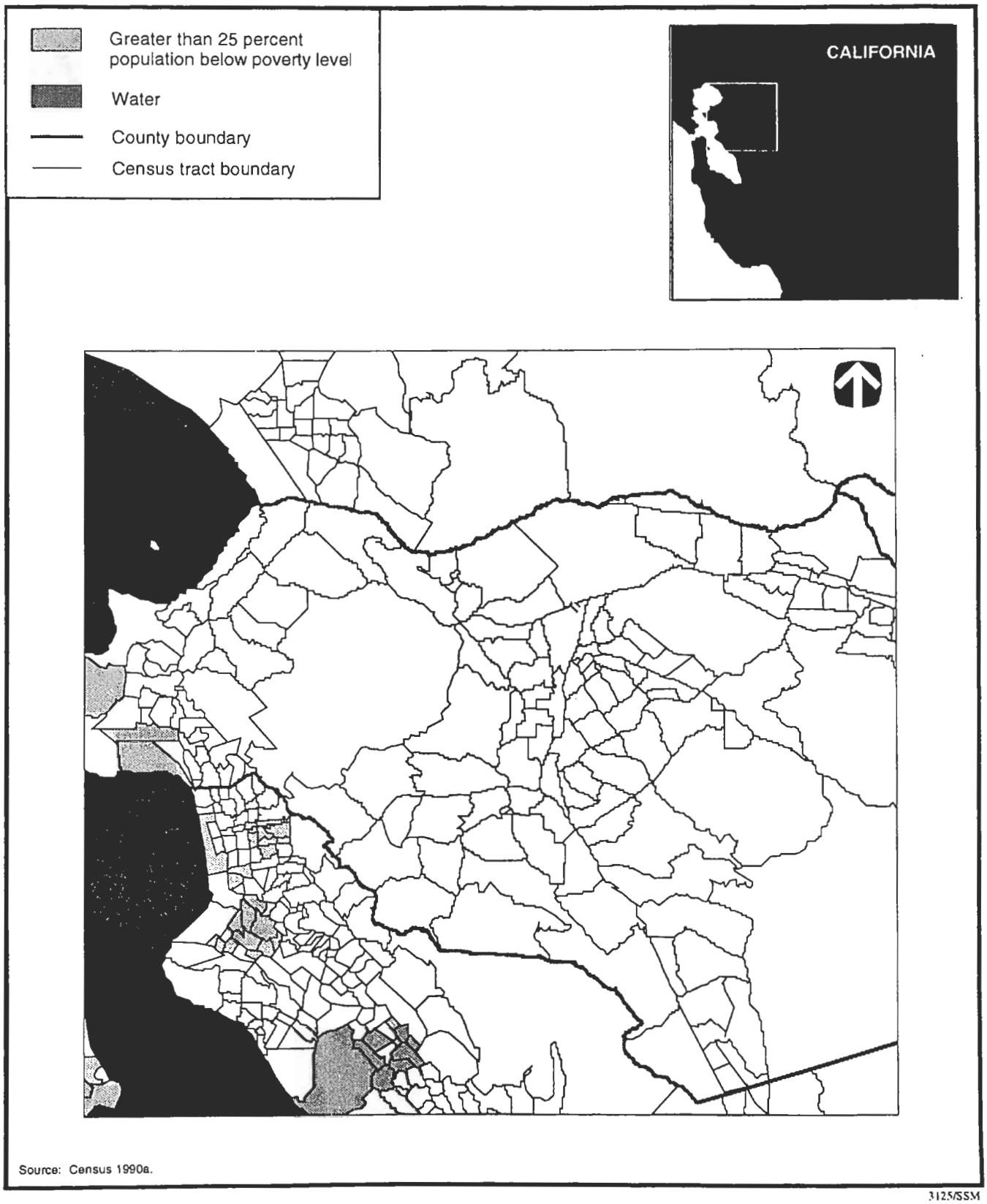


FIGURE D.2.4–14.—*Low-Income Population Distribution by Poverty Status for Lawrence Livermore National Laboratory and Surrounding Area* [Page 2 of 5].

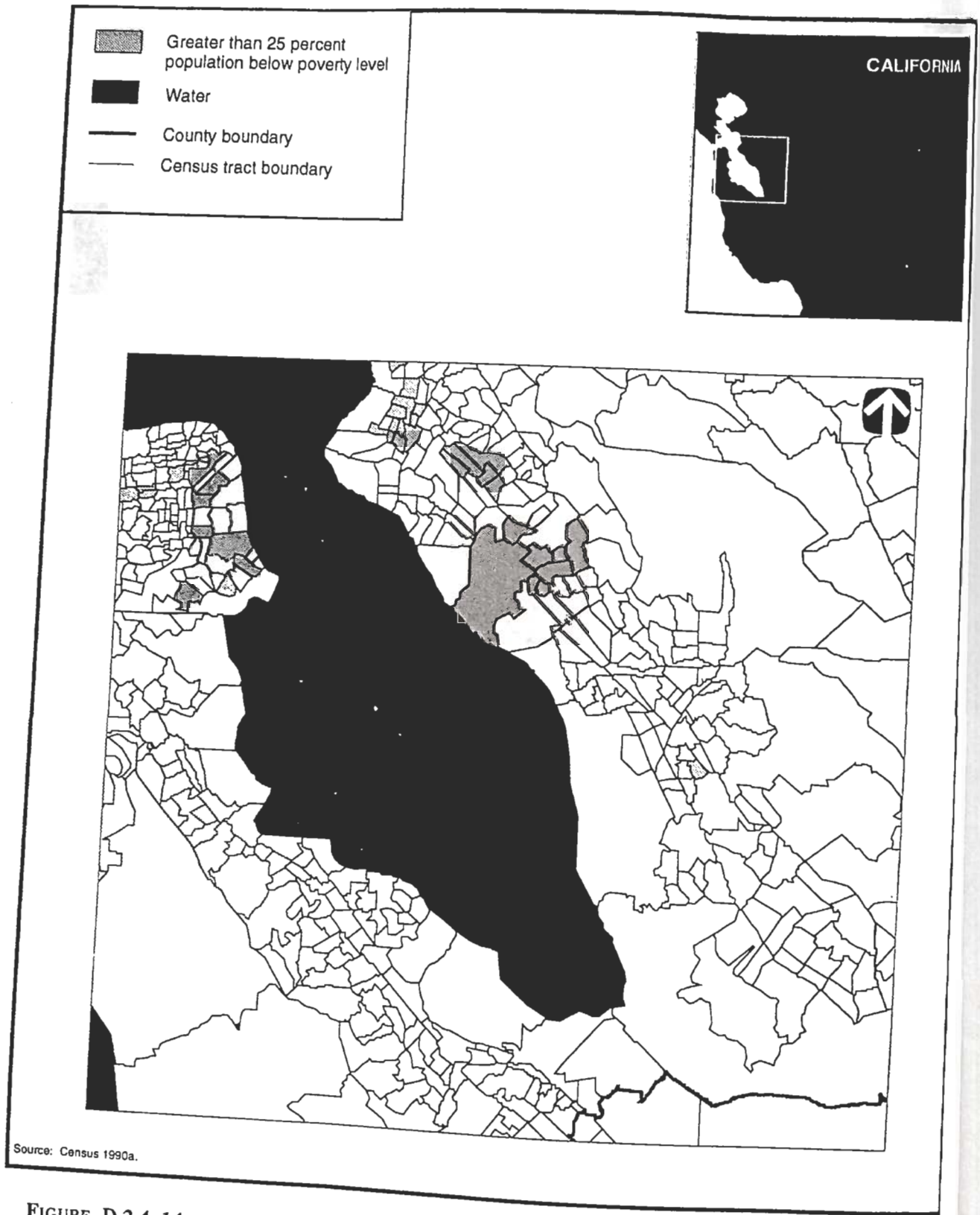


FIGURE D.2.4–14.—*Low-Income Population Distribution by Poverty Status for Lawrence Livermore National Laboratory and Surrounding Area* [Page 3 of 5].

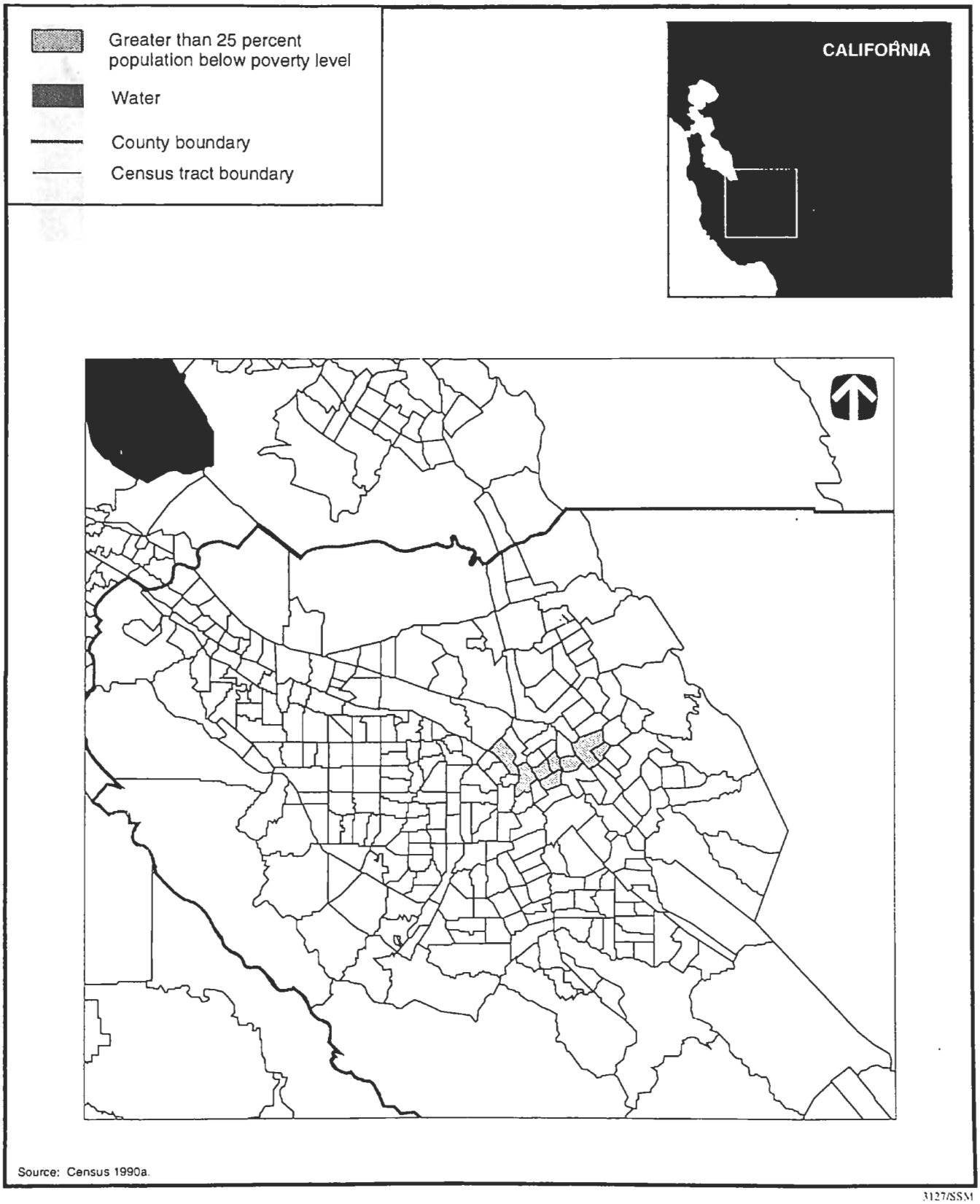


FIGURE D.2.4–14.—*Low-Income Population Distribution by Poverty Status for Lawrence Livermore National Laboratory and Surrounding Area* [Page 4 of 5].

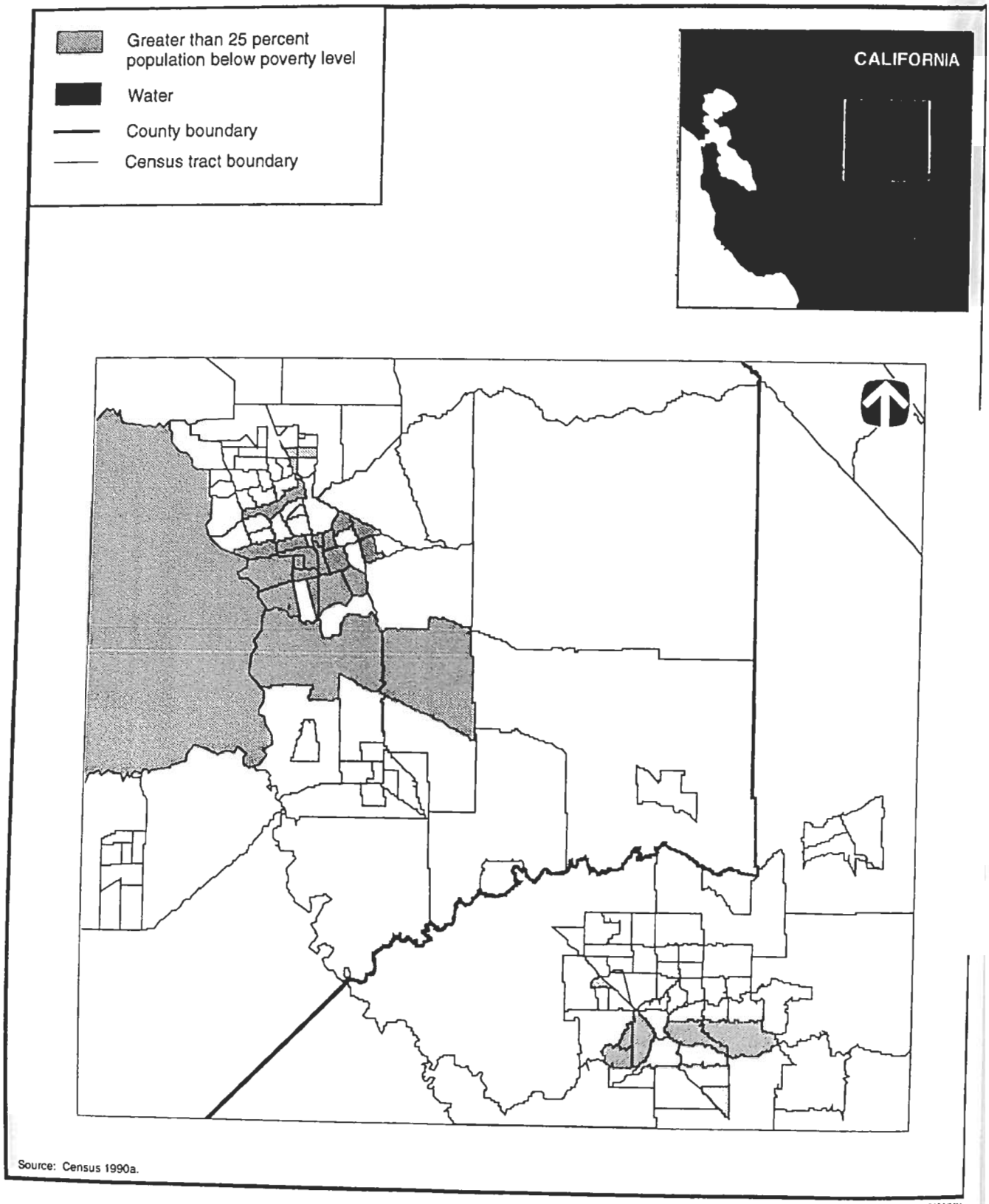


FIGURE D.2.4–14.—*Low-Income Population Distribution by Poverty Status for Lawrence Livermore National Laboratory and Surrounding Area* [Page 5 of 5].

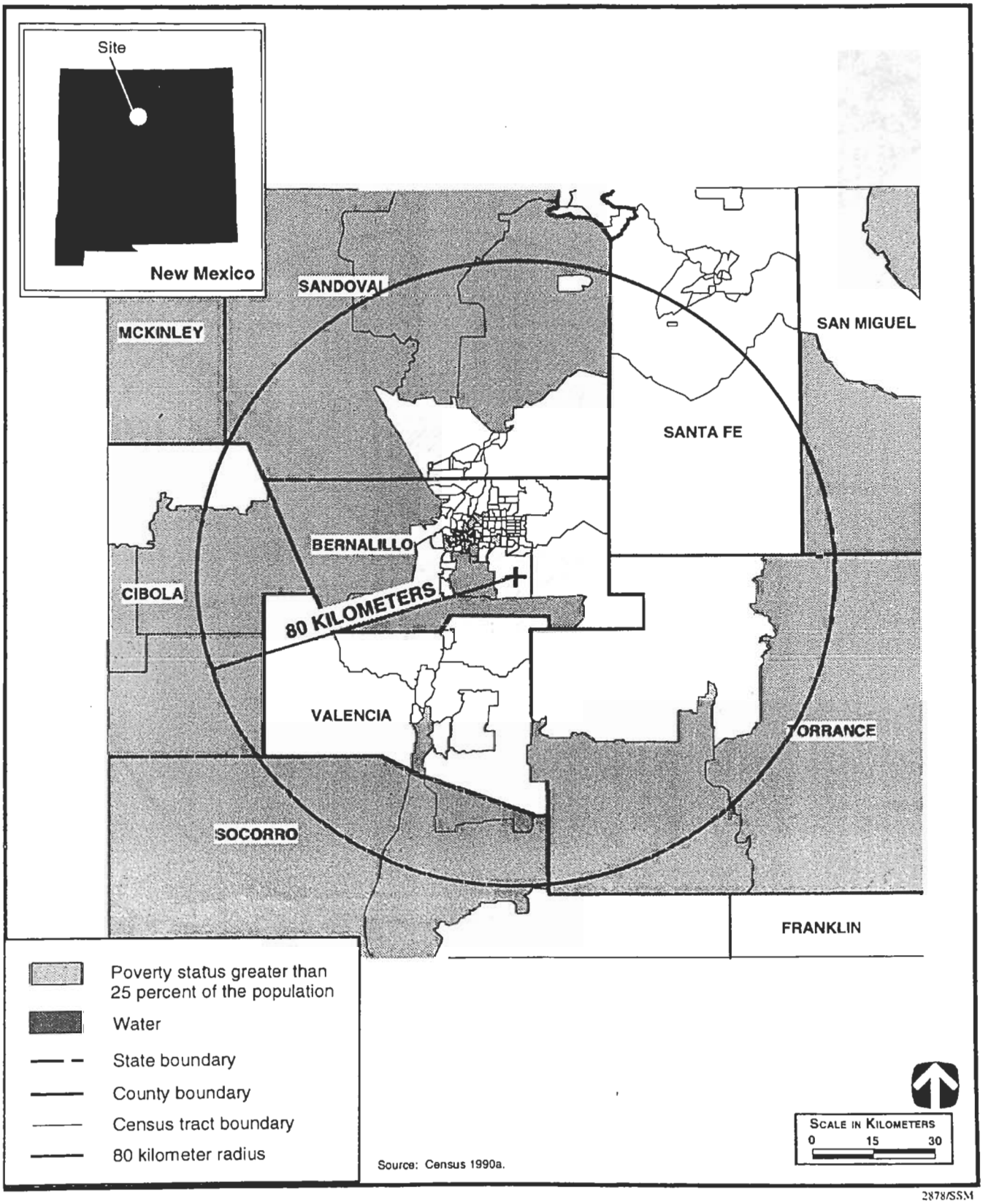


FIGURE D.2.4–15.—*Low-Income Population Distribution by Poverty Status for Sandia National Laboratories and Surrounding Area.*

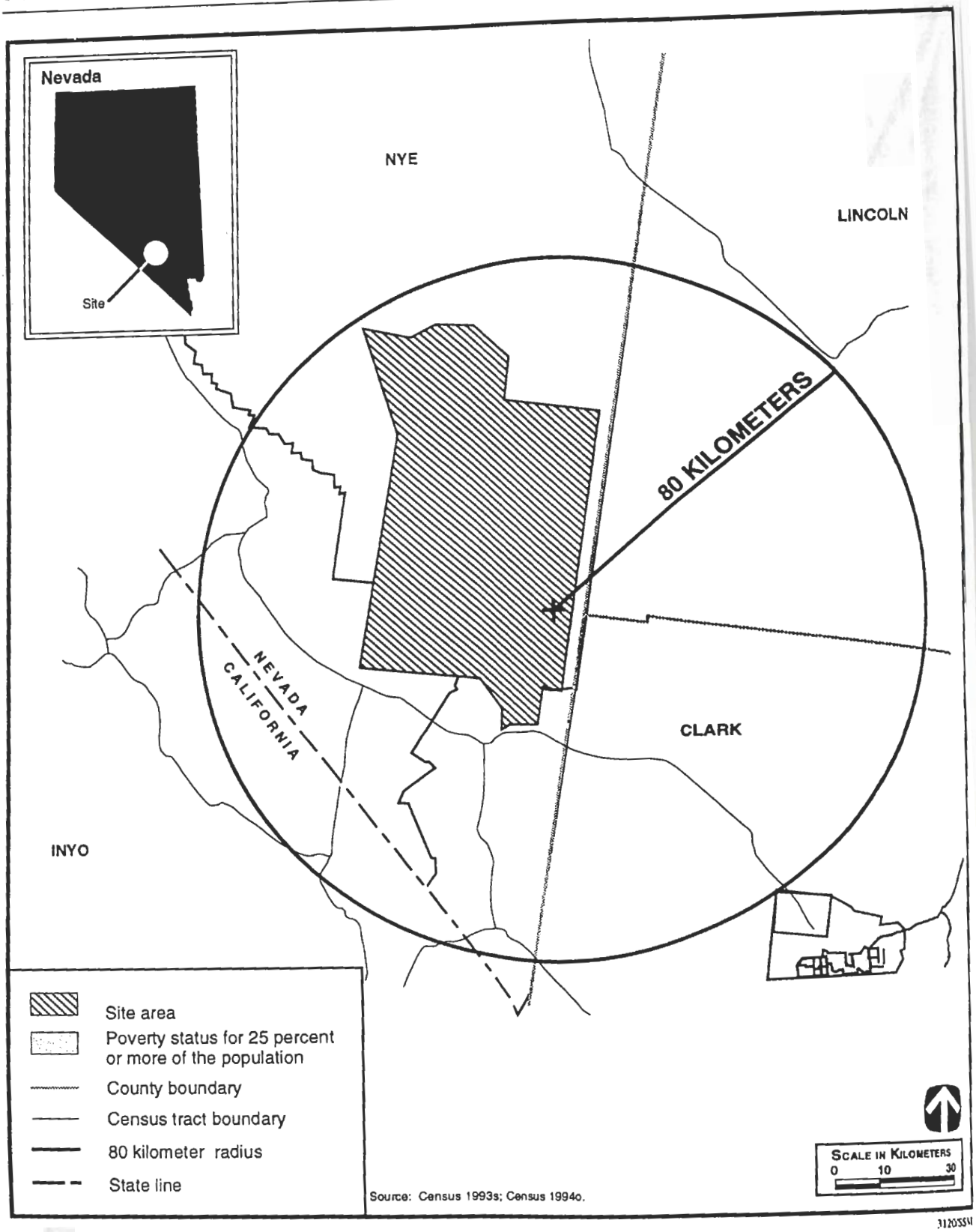


FIGURE D.2.4–16.—*Low-Income Population Distribution by Poverty Status for Nevada Test Site and Surrounding Area.*

APPENDIX E

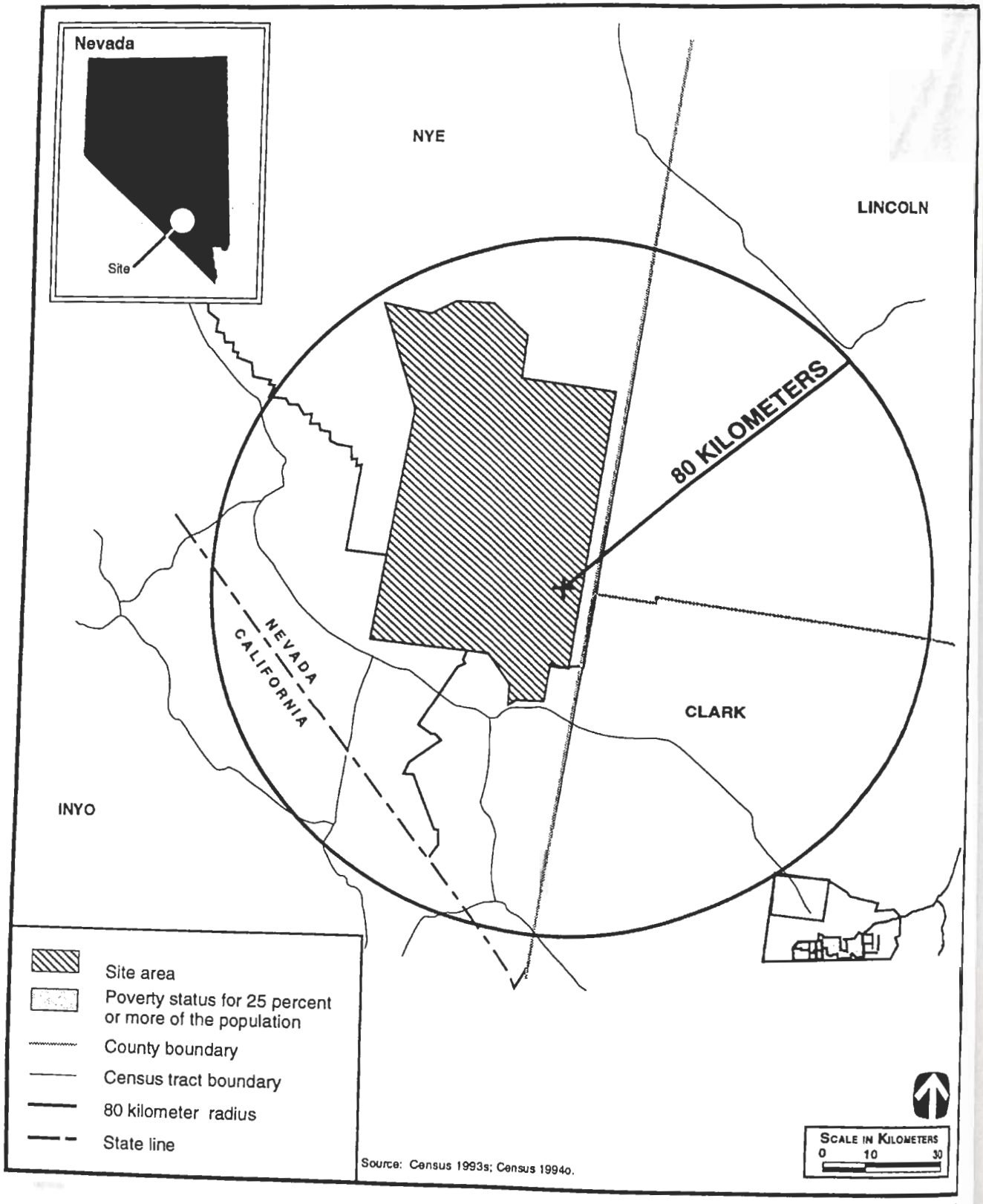


FIGURE D.2.4–16.—*Low-Income Population Distribution by Poverty Status for Nevada Test Site and Surrounding Area.*

APPENDIX E

Appendix E

APPENDIX E: HUMAN HEALTH

E.1 INTRODUCTION

Supplemental information is presented in this appendix on the potential impacts to humans from the normal operational releases of radioactivity and hazardous chemicals from the Stockpile Stewardship and Management Program facilities. This information is intended to support assessments of normal operation for the management and stewardship facilities described in sections 4.2.3.9, 4.3.3.9, 4.4.3.9, 4.5.3.9, 4.6.3.9, 4.7.3.9, 4.8.3.9, and 4.9.3.9 of this programmatic environmental impact statement (PEIS). Section E.2 provides information on radiological impacts while section E.3 provides information on hazardous chemical impacts.

E.2 RADIOLOGICAL IMPACTS TO HUMAN HEALTH

Section E.2 presents supporting information on the potential radiological impacts to humans during normal operation of the PEIS alternatives. This section provides the reader with background information on the nature of radiation (section E.2.1), the methodology used to calculate radiological impacts (section E.2.2), and radiological releases from stockpile management facilities (section E.2.3). Releases associated with the No Action alternative for each site can be found in the referenced site environmental reports.

E.2.1 Background

E.2.1.1 *Nature of Radiation and Its Effects on Humans*

What is Radiation? Humans are constantly exposed to radiation from the solar system and from the earth's rocks and soil. This radiation contributes to the natural background radiation that has always surrounded us. But there are also manmade sources of radiation, such as medical and dental x rays, household smoke detectors, and materials released from nuclear and coal-fired powerplants.

All matter in the universe is composed of atoms, and radiation comes from the activity of these tiny particles. Atoms are made up of even smaller particles (protons, neutrons, and electrons). The number and arrangement of these particles distinguishes one atom from another.

Atoms of different types are known as elements. There are over 100 natural and manmade elements. Some of these elements, such as uranium, radium, plutonium, and thorium, share a very important quality: they are unstable. As they change into more stable forms, invisible waves of energy or particles, known as ionizing radiation, are released. Radioactivity is the emitting of this radiation.

Ionizing radiation refers to the fact that this energy force can ionize, or electrically charge atoms by stripping off electrons. Ionizing radiation can cause a change in the chemical composition of many things, including living tissue (organs), which can affect the way they function.

The effects on people of radiation that is emitted during disintegration (decay) of a radioactive substance depends on the kind of radiation (alpha and beta particles and gamma and x rays) and the total amount of radiation energy absorbed by the body. Alpha particles are the heaviest of these direct types of ionizing radiation, and despite a speed of about 16,100 kilometers (km) per second(s) (kps) (10,000 miles [mi] per second [mps]), they can travel only a few inches in the air. Alpha particles lose their energy almost as soon as they collide with anything. They can easily be stopped by a sheet of paper or the skin's surface.

Beta particles are much lighter than alpha particles. They can travel as fast as 161,000 kps (100,000 mps) and can travel in the air for a distance of about 3 meters (m) (10 feet [ft]). Beta particles can pass through a sheet of paper but may be stopped by a thin sheet of aluminum foil or glass.

Gamma and x rays, unlike alpha or beta particles, are waves of pure energy. Gamma rays travel at the speed of light (300,000 kps [186,000 mps]). Gamma radiation is very penetrating and requires a thick wall of concrete, lead, or steel to stop it.

The neutron is another particle that contributes to radiation exposure, both directly and indirectly. Indirect exposure is associated with the gamma rays and alpha particles that are emitted following neutron capture in matter. A neutron has about one quarter the weight of an alpha particle and can travel at speeds of up to 38,600 kps (24,000 mps). Neutrons are more penetrating than beta particles, but less penetrating than gamma rays. They can effectively be shielded by water, graphite, paraffin, or concrete.

The radioactivity of a material decreases with time. The time it takes a material to lose half of its original radioactivity is its half-life. For example, a quantity of iodine-131, a material that has a half-life of 8 days, will lose half of its radioactivity in that amount of time. In 8 more days, half of the remaining radioactivity will be lost, and so on. Eventually, the radioactivity will essentially disappear. Each radioactive element has a characteristic half-life. The half-lives of various radioactive elements may vary from millionths of a second to millions of years.

As a radioactive element gives up its radioactivity, it often changes to an entirely different element, one that may or may not be radioactive. Eventually, a stable element is formed. This transformation may take place in several steps and is known as a decay chain. Radium, for example, is a naturally occurring radioactive element with a half-life of 1,622 years. It emits an alpha particle and becomes radon, a radioactive gas with a half-life of only 3.8 days. Radon decays to polonium and, through a series of steps, to bismuth and ultimately to lead.

Units of Radiation Measure. Scientists and engineers use a variety of units to measure radiation. These different units can be used to determine the amount, type, and intensity of radiation. Just as heat can be measured in terms of its intensity or its effects, using units of calories or degrees, amounts of radiation can be measured in curies, rads, or rems.

The curie, named after the French scientists Marie and Pierre Curie, describes the "intensity" of a sample of radioactive material. The rate of decay of 1 gram of radium is the basis of this unit of measure. It is equal to 3.7×10^{10} disintegrations (decays) per second.

The total energy absorbed per unit quantity of ti is referred to as absorbed dose. The rad is the un measurement for the physical absorption of radia Much like sunlight heats the pavement by giving an amount of energy to it, radiation gives up rad energy to objects in its path. One rad is equal to amount of radiation that leads to the deposition 0.01 joule of energy per kilogram (kg) of absorb material.

A rem is a measurement of the dose from radiati based on its biological effects. The rem is used measure the effects of radiation on the body, mu like degrees Celsius can be used to measure th effects of sunlight heating pavement. Thus, 1 rem one type of radiation is presumed to have the sa biological effects as 1 rem of any other type of radia tion. This standard allows comparison of the biolog ical effects of radionuclides that emit different type of radiation.

An individual may be exposed to ionizing radiation externally from a radioactive source outside the body and/or internally from ingesting radioactive material. An external dose is delivered only during the actua time of exposure to the external radiation source. An internal dose, however, continues to be delivered as long as the radioactive source is in the body, although both radioactive decay and elimination of the radio nuclide by ordinary metabolic processes decrease the dose rate with the passage of time. The dose from internal exposure is calculated over 50 years following the initial exposure.

The three types of doses calculated in this PEIS include an external dose, an internal dose, and a combined external and internal dose. Each type of dose is discussed below.

External Dose. The external dose can arise from several different pathways. All these pathways are similar because the radiation causing the exposure is external to the body. In this PEIS, these pathways include being exposed to a cloud of radiation passing over the receptor, standing on ground that is contami nated with radioactivity, swimming in contaminated water, and boating in contaminated water. The appro priate measure of dose is called the effective dose equivalent. It should be noted that if the receptor departs from the source of radiation exposure, his

dose rate will be reduced. It is assumed that external exposure occurs uniformly during the year.

Internal Dose. The internal dose arises from a radiation source entering the human body through ingestion of contaminated food and water or inhalation of contaminated air. In this PEIS, pathways for internal exposure include ingestion of crops contaminated by airborne radiation that has been deposited on the crops or by irrigation of crops using contaminated water sources, ingestion of animal products from animals that ingested contaminated food, ingestion of contaminated water, inhalation of contaminated air, and absorption of contaminated water through the skin during swimming. Unlike external exposures, once radioactive material enters the body, it remains there for various periods of time depending on decay and biological elimination rates. The unit of measure for internal doses is the committed dose equivalent. It is the internal dose that each body organ receives from 1 "year intake" (ingestion plus inhalation). Normally, a 50- or 70-year dose-commitment period is used (i.e., the 1-year intake period plus 49 or 69 years). The dose rate increases during the 1 year of intake. The dose rate, after the 1 year of intake, slowly declines as the radioactivity in the body continues to produce a dose. The integral of the dose rate over the 50 or 70 years gives the committed dose equivalent. In this PEIS, a 50-year dose-commitment period was used.

The various organs of the body have different susceptibilities to harm from radiation. The committed effective dose equivalent takes these different susceptibilities into account and provides a broad indicator of the risk to the health of an individual from radiation. It is obtained by multiplying the committed dose equivalent in each major organ or tissue by a weighting factor associated with the risk susceptibility of the tissue or organ, then summing the totals.

The committed dose equivalent to an organ is larger than the committed effective dose equivalent because the organ has a weighting factor of less than one. The concept of committed effective dose equivalent applies only to internal pathways.

Differences in radionuclide characteristics lead to different internal doses. For example, for the same amount of radioactivity, in curies, taken into the body, the dose from tritium is much less than from uranium or plutonium. Tritium emits a weak beta particle and is biologically eliminated from the body over several weeks. Uranium and plutonium emit relatively high-energy alpha particles and are retained in the body for periods of several months to many years.

Combined External and Internal Dose. For convenience, the sum of the committed effective dose equivalent from internal pathways and the effective dose equivalent from external pathways is also called the committed effective dose equivalent in this PEIS (note that in DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, this quantity is called the effective dose equivalent).

The units used in this PEIS for committed dose equivalent, effective dose equivalent, and committed effective dose equivalent to an individual are the rem and millirem (mrem) (1/1000 of 1 rem). The corresponding unit for the collective dose to a population (the sum of the doses to members of the population, or the product of the number of exposed individuals and their average dose) is the person-rem.

Sources of Radiation. The average American receives a total of about 350 mrem per year from all sources of radiation, both natural and manmade. The sources of radiation can be divided into six different categories: cosmic radiation, terrestrial radiation, internal radiation, consumer products, medical diagnosis and therapy, and other sources. Each category is discussed below.

Cosmic radiation is ionizing radiation resulting from energetic charged particles from space continuously hitting the earth's atmosphere. These particles and the secondary particles and photons they create are cosmic radiation. Because the atmosphere provides some shielding against cosmic radiation, the intensity of this radiation increases with altitude above sea level. For the sites considered in this PEIS, the cosmic radiation ranged from about 30 to 50 mrem per year. The average annual dose to people in the United States is about 27 mrem.

External terrestrial radiation is the radiation emitted from the radioactive materials in the earth's rocks and soils. The average annual dose from external terrestrial radiation is about 28 mrem. The external ter-

restrial radiation for the sites in this PEIS ranged from about 30 to 75 mrem per year.

Internal radiation arises from the human body metabolizing natural radioactive material that has entered the body by inhalation or ingestion. Natural radionuclides in the body include isotopes of uranium, thorium, radium, radon, polonium, bismuth, potassium, rubidium, and carbon. The major contributors to the annual dose equivalent for internal radioactivity are the short-lived decay products of radon which contribute about 200 mrem per year. The average dose from other internal radionuclides is about 39 mrem per year.

Consumer products also contain sources of ionizing radiation. In some products, like smoke detectors and airport x-ray machines, the radiation source is essential to the products' operation. In other products, such as televisions and tobacco products, the radiation occurs incidentally to the product function. The average annual dose is about 10 mrem.

Radiation is an important diagnostic medical tool and cancer treatment. Diagnostic x rays result in an average annual exposure of 39 mrem. Nuclear medical procedures result in an average annual exposure of 14 mrem.

There are a few additional sources of radiation that contribute minor doses to individuals in the United States. The doses from nuclear fuel cycle facilities, such as uranium mines, mills, and fuel processing plants; nuclear power plants; and transportation routes has been estimated to be less than 1 mrem per year. Radioactive fallout from atmospheric atomic bomb tests, emissions of radioactive material from Department of Energy (DOE) facilities, emissions from certain mineral extraction facilities, and transportation of radioactive materials contributes less than 1 mrem per year to the average dose to an individual. Air travel contributes approximately 1 mrem per year to the average dose.

The collective (or population) dose to an exposed population is calculated by summing the estimated doses received by each member of the exposed population. This total dose received by the exposed population is measured in person-rem. For example, if 1,000 people each received a dose of 1 mrem (0.001 rem), the collective dose is 1,000 persons x 0.001 rem = 1.0 person-rem. Alternatively, the same collective dose (1.0 person-rem) results from 500 people, each of whom received a dose of 2 mrem (500 persons x 2 mrem = 1 person-rem).

Limits of Radiation Exposure. The amount of manmade radiation that the public may be exposed to is limited by Federal regulations. Although most scientists believe that radiation absorbed in small doses over several years is not harmful, U.S. Government regulations assume that the effects of all radiation exposures are cumulative.

The exposure to a member of the general public from DOE facility releases into the atmosphere is limited by the Environmental Protection Agency (EPA) to an annual dose of 10 mrem, in addition to the natural background and medical radiation normally received (40 *Code of Federal Regulations* [CFR] 61, Subpart H). DOE also limits to 10 mrem, the dose annually received from material released into the atmosphere (DOE Order 5400.5). EPA and DOE also limit the annual dose to the general public from radioactive releases to drinking water to 4 mrem (40 CFR 141, DOE Order 5400.5). The DOE annual limit of radiation dose to a member of the general public from all DOE facilities is 100 mrem total from all pathways (DOE Order 5400.5). For people working in an occupation that involves radiation, DOE and the Nuclear Regulatory Commission (NRC) limit dose to 5 rem (5,000 mrem) in any one year (10 CFR 20, 10 CFR 835).

E.2.1.2 *Health Effects*

Radiation exposure and its consequences are topics of interest to the general public. For this reason, this PEIS places much emphasis on the consequences of exposure to radiation, even though the effects of radiation exposure under most circumstances evaluated in this PEIS are small. This section explains the basic concepts used in the evaluation of radiation effects in order to provide the background for later discussion of impacts.

Radiation can cause a variety of ill-health effects in people. The most significant ill-health effects that result from environmental and occupational radiation exposure are cancer fatalities. These ill-health

effects are referred to as "latent" cancer fatalities because the cancer may take many years to develop and for death to occur and may not actually be the cause of death. In the discussions that follow, it should be noted that all fatal cancers are latent; therefore, the term "latent" is not used.

Health impacts from radiation exposure, whether from sources external or internal to the body, generally are identified as "somatic" (affecting the individual exposed) or "genetic" (affecting descendants of the exposed individual). Radiation is more likely to produce somatic effects rather than genetic effects. Therefore, for this PEIS, only the somatic risks are presented. The somatic risks of most importance are the induction of cancers. Except for leukemia, which can have an induction period (time between exposure to carcinogen and cancer diagnosis) of as little as 2 to 7 years, most cancers have an induction period of more than 20 years.

For a uniform irradiation of the body, the incidence of cancer varies among organs and tissues. The thyroid and skin demonstrate a greater sensitivity than other organs; however, such cancers also produce relatively low mortality rates because they are relatively amenable to medical treatment. Because of the readily available data for cancer mortality rates and the relative scarcity of prospective epidemiologic studies, somatic effects leading to cancer fatalities rather than cancer incidence are presented in this PEIS. The numbers of cancer fatalities can be used to compare the risks among the various alternatives.

The fatal cancer risk estimators presented in this appendix for radiation technically apply only to low-Linear Energy Transfer radiation (gamma rays and beta particles). However, on a per rem rather than a per rad basis, the fatal risk estimators are higher for this type of radiation than for high-Linear Energy Transfer radiation (alpha particles). In this PEIS, the low-Linear Energy Transfer risk estimators are conservatively assumed to apply to all radiation exposures.

The National Research Council's Committee on the Biological Effects of Ionizing Radiations (BEIR) has prepared a series of reports to advise the U.S. Government on the health consequences of radiation exposure. The latest of these reports, *Health Effects of Exposure to Low Levels of Ionizing Radiation BEIR V,* published in 1990, provides the most current estimates for excess mortality from leukemia and cancers other than leukemia expected to result from exposure to ionizing radiation. The BEIR V Report updates the models and risk estimates provided in the earlier report of the BEIR III Committee, *The Effects of Exposure of Populations to Low-Levels of Ionizing Radiation,* published in 1980. BEIR V models were developed for application to the U.S. population.

BEIR V provides estimates that are consistently higher than those in BEIR III. This is attributed to several factors, including the use of a linear dose response model for cancers other than leukemia, revised dosimetry for the Japanese atomic bomb survivors, and additional followup studies of the atomic bomb survivors and other cohorts. BEIR III employs constant relative and absolute risk models, with separate coefficients for each sex and several age-at-exposure groups, while BEIR V develops models in which the excess relative risk is expressed as a function of age at exposure, time after exposure, and sex for each of several cancer categories. BEIR III models were based on the assumption that absolute risks are comparable between the atomic bomb survivors and the U.S. population, while BEIR V models were based on the assumption that the relative risks are comparable. For a disease such as lung cancer, where baseline risks in the United States are much larger than those in Japan, the BEIR V approach leads to larger risk estimates than the BEIR III approach.

The models and risk coefficients in BEIR V were derived through analyses of relevant epidemiologic data, including the Japanese atomic bomb survivors, ankylosis spondylitis patients, Canadian and Massachusetts fluoroscopy patients (breast cancer), New York postpartum mastitis patients (breast cancer), Israel tinea capitis patients (thyroid cancer), and Rochester thymus patients (thyroid cancer). Models for leukemia, respiratory cancer, digestive cancer, and other cancers used only the atomic bomb survivor data, although results of analyses of the ankylosis spondylitis patients were considered. Atomic bomb survivor analyses were based on revised dosimetry with an assumed Relative Biological Effectiveness of 20 for neutrons and were restricted to doses of less than 400 rads. Estimates of risks of fatal cancers other than leukemia were obtained by totaling the estimates for breast cancer,

respiratory cancer, digestive cancer, and other cancers.

Risk Estimates for Doses Received During an Accident. BEIR V includes risk estimates for a single exposure of 10 rem to a population of 100,000 people (10^6 person-rem). In this case, fatality estimates for leukemia, breast cancer, respiratory cancer, digestive cancer, and other cancers are given for both sexes and nine age-at-exposure groups. These estimates, based on the linear model, are summarized in table E.2.1.2–1. The average risk estimate from all ages and both sexes is 885 excess cancer fatalities per million person-rem. This value has been conservatively rounded up to 1,000 excess cancer fatalities per million person-rem.

TABLE E.2.1.2–1.—*Lifetime Risks per 100,000 Persons Exposed to a Single Exposure of 10 Rem*

	Type of Fatal Cancer		
Gender	Leukemia[a]	Cancers Other Than Leukemia	Total Cancers
Male	220	660	880
Female	160	730	890
Average	190	695	885[b]

[a] These are the linear estimates and are double the linear-quadratic estimates provided in BEIR V for leukemia at low doses and dose-rates.

[b] This value has been rounded up to 1,000 excess cancer fatalities per million person-rem.

Source: NAS 1990a.

Although values for other health effects are not presented in this PEIS, the risk estimators for nonfatal cancers and for genetic disorders in future generations are estimated to be approximately 200 and 260 per million person-rem, respectively. These values are based on information presented in the *1990 Recommendations of the International Commission on Radiological Protection* (ICRP Publication 60) and are seen to be 20 and 26 percent, respectively, of the fatal cancer estimator (ICRP 1991a:22). Thus, if the number of excess fatal cancers is projected to be "Z", the number of excess genetic disorders would be 0.26xZ.

Risk Estimates for Doses Received During Normal Operation. For low doses and dose rates, a linear-quadratic model was found to provide a significantly better fit to the data for leukemia than a linear one, and leukemia risks were based on a linear quadratic function. This reduces the effects by a factor of two over estimates that are obtained for the linear model. For other cancers, linear models were found to provide an adequate fit to the data, and were used for extrapolation to low doses. However, the BEIR V Committee recommended reducing these linear estimates by a factor between 2 and 10 for doses received at low dose rates. For this PEIS, a risk reduction factor of 2 was adopted for conservatism.

Based on the above discussion, the resulting dose-to-risk conversion factor would be equal to half the value observed for accident situations or approximately 500 excess fatal cancers per million person-rem (0.0005 excess fatal cancers per person-rem). This is the risk value used in this PEIS to calculate fatal cancers to the general public during normal operation. For workers, a dose-to-risk conversion factor of 400 excess fatal cancers per million person-rem (0.0004 excess fatal cancers per person-rem) is used in this PEIS. This lower value reflects the absence of children in the workforce. Again, based on information provided in ICRP Publication 60, the health risk estimators for nonfatal cancers and genetic disorders among the public are 20 percent and 26 percent, respectively, of the fatal cancer dose-to-risk conversion factor. For workers, the health risk estimators for nonfatal cancers and genetic disorders are both 20 percent of the fatal cancer dose-to-risk conversion factor. For this PEIS, only fatal cancers are presented.

The risk estimates may be applied to calculate the effects of exposing a population to radiation. For example, in a population of 100,000 people exposed only to natural background radiation (0.3 rem per year), 15 cancer fatalities per year would be inferred to be caused by the radiation (100,000 persons x 0.3 rem per year x 0.0005 cancer fatalities per person-rem = 15 cancer fatalities per year).

Sometimes, calculations of the number of excess cancer fatalities associated with radiation exposure do not yield whole numbers and, especially in environmental applications, may yield numbers less than 1.0. For example, if a population of 100,000 were exposed as above, but to a total dose of only 0.001 rem, the collective dose would be 100 person-rem, and the corresponding estimated number of cancer

fatalities would be 0.05 (100,000 persons x 0.001 rem x 0.0005 cancer fatalities/person-rem = 0.05 fatal cancers).

How should one interpret a nonintegral number of cancer fatalities such as 0.05? The answer is to interpret the result as a statistical estimate. That is, 0.05 is the average number of deaths that would result if the same exposure situation were applied to many different groups of 100,000 people. In most groups, no person (0 people) would incur a cancer fatality from the 0.001 rem dose each member would have received. In a small fraction of the groups, one fatal cancer would result; in exceptionally few groups, two or more fatal cancers would occur. The average number of deaths over all the groups would be 0.05 fatal cancers (just as the average of 0, 0, 0, and 1 is 1/4, or 0.25). The most likely outcome is 0 cancer fatalities.

These same concepts apply to estimating the effects of radiation exposure on a single individual. Consider the effects, for example, of exposure to background radiation over a lifetime. The "number of cancer fatalities" corresponding to a single individual's exposure over a (presumed) 72-year lifetime to 0.3 rem per year is the following:

> 1 person x 0.3 rem/year x 72 years x 0.0005 cancer fatalities/person-rem = 0.011 cancer fatalities.

Again, this should be interpreted in a statistical sense; that is, the estimated effect of background radiation exposure on the exposed individual would produce a 1.1-percent chance that the individual might incur a fatal cancer caused by the exposure. Presented another way, this method estimates that approximately 1.1 percent of the population might die of cancers induced by the background radiation.

E.2.2 Methodology for Estimating Radiological Impacts of Normal Operation

The radiological impacts of normal operation of alternatives were calculated using Version 1.485 of the GENII computer code. Site-specific and technology-specific input data were used, including location, meteorology, population, food production and consumption, and source terms. The GENII code was used for analysis of normal operations and design basis accidents. Section E.2.2.1 briefly describes GENII and outlines the approach used for normal operations.

E.2.2.1 *GENII Computer Code*

The GENII computer model, developed by Pacific Northwest Laboratory for DOE, is an integrated system of various computer modules that analyze environmental contamination resulting from acute or chronic releases to, or initial contamination in, air, water, or soil. The model calculates radiation doses to individuals and populations. The GENII computer model is well documented for assumptions, technical approach, methodology, and quality assurance issues (*GENII — The Hanford Environmental Radiation Dosimetry Software System* [December 1988]). The GENII computer model has gone through extensive quality assurance and quality control steps. These include the comparison of results from model computations against those from hand calculations, and the performance of internal and external peer reviews. Recommendations given in these reports were incorporated into the final GENII computer model, as deemed appropriate.

For this PEIS only the ENVIN, ENV, and DOSE computer modules were used. The codes are connected through data transfer files. The output of one code is stored in a file that can be used by the next code in the system. In addition, a computer code called CREGENII was prepared to aid the user with the preparation of input files into GENII.

CREGENII. The CREGENII code helps the user, through a series of interactive menus and questions, prepare a text input file for the environmental dosimetry programs. In addition, CREGENII prepares a batch processing file to manage the file handling needed to control the operations of subsequent codes and to prepare an output report.

ENVIN. The ENVIN module of the GENII code controls the reading of the input files prepared by CREGENII and organizes the input for optimal use in the environmental transport and exposure module, ENV. The ENVIN code interprets the basic input, reads the basic GENII data libraries and other optional input files, and organizes the input into sequential segments on the basis of radionuclide decay chains.

A standardized file that contains scenario, control, and inventory parameters is used as input to ENVIN. Radionuclide inventories can be entered as functions of releases to air or water, concentrations in basic environmental media (air, soil, or water), or concentrations in foods. If certain atmospheric dispersion options have been selected, this module can generate tables of atmospheric dispersion parameters that will be used in later calculations. If the finite plume air submersion option is requested in addition to the atmospheric dispersion calculations, preliminary energy-dependent finite plume dose factors also are prepared. The ENVIN module prepares the data transfer files that are used as input by the ENV module; ENVIN generates the first portion of the calculation documentation—the run input parameters report.

ENV. The ENV module calculates the environmental transfer, uptake, and human exposure to radionuclides that result from the chosen scenario for the user-specified source term. The code reads the input files from ENVIN and then, for each radionuclide chain, sequentially performs the precalculations to establish the conditions at the start of the exposure scenario. Environmental concentrations of radionuclides are established at the beginning of the scenario by assuming decay of preexisting sources, considering biotic transport of existing subsurface contamination, and defining soil contamination from continuing atmospheric or irrigation depositions. Then, for each year of postulated exposure, the code estimates air, surface soil, deep soil, groundwater, and surface water concentrations of each radionuclide in the chain. Human exposures and intakes of each radionuclide are calculated for pathways of external exposure from finite atmospheric plumes, inhalation, external exposure from contaminated soil, sediments, and water, external exposure from special geometries, and internal exposures from consumption of terrestrial foods, aquatic foods, drinking water, animal products, and inadvertent intake of soil. The intermediate information on annual media concentrations and intake rates are written to data transfer files. Although these may be accessed directly, they are usually used as input to the DOSE module of GENII.

GENII is a general purpose computer code used to model dispersion, transport, and long-term exposure effects of specific radionuclides and pathways. Sophisticated codes such as UFOTRI and ETMO (Environmental Tritium Model) are used exclusiv for modeling tritium transport and dosimetry. T UFOTRI and ETMOD codes were not chosen for in this PEIS because of the lack of information detailed facility design and on the breakdown tritium into elemental and tritiated water forms, because these codes cannot be used for modeling exposure effects of radionuclides other than triti GENII was chosen because it can model both air surface transport pathways and is not restricted any radionuclides.

DOSE. The DOSE module reads the annual inta and exposure rates defined by the ENV module a converts the data to radiation dose. External dose calculated with precalculated factors from t EXTDF module or from a data file prepared outs of GENII. Internal dose is calculated with precal lated factors from the INTDF module.

EXTDF. The EXTDF module calculates the extern dose-rate factors for submersion in an infinite clou of radioactive materials, immersion in contaminat water, and direct exposure to plane or slab sources radionuclides. EXTDF was not used. Instead, th dose rate factors listed in *External Dose Rate Factor for Calculation of Dose to the Public* (DOE/EH 0070) were used for this PEIS.

INTDF. Using the *Limits for Intakes of Radionu clides by Workers* (ICRP Publication 30) model, th INTDF module calculates the internal (inhalation and ingestion) dose conversion factors of radionu clides for specific organs. The factors generated by INTDF were used for the calculations presented in this PEIS.

E.2.2.2 *Data and Assumptions*

In order to perform the dose assessments for this PEIS, different types of data must be collected and/or generated. In addition, calculational assumptions have to be made. This section discusses the data collected and/or generated for use in the dose assess ment and assumptions made for this PEIS.

Meteorological Data. The meteorological data used for all applicable DOE sites were in the form of joint frequency data files. A joint frequency data file is a table listing the fractions of time the wind blows in

certain direction, at a certain speed, and within a certain stability class. The joint frequency data files were based on measurements over a 1-year period at various locations and at different heights at the sites. Average meteorological conditions (averaged over the 1-year period) were used for normal operation. For use in design basis accidents, the 50 percentile option was used.

Population Data. Population distributions were based on *1990 Census of Population and Housing* data. Projections were determined for the year 2030 for areas within 80 km (50 mi) of the proposed facilities at each candidate site. This year of analysis was selected as conservatively representative of the population over the operational period evaluated, and was used in the impact assessments. The population was spatially distributed on a circular grid with 16 directions and 10 radial distances up to 80 km (50 mi). The grid was centered on the facility from which the radionuclides were assumed to be released.

Source Term Data. The source terms (quantities of radionuclides released into the environment over a given period) were estimated on the basis of latest conceptual designs of facilities and experience with similar facilities. The source terms used to generate the estimated impacts of normal operation are provided in section E.2.3.

Food Production and Consumption Data. Data from the *1987 Census of Agriculture* were used to generate site-specific data for food production. Food production was spatially distributed on the same circular grid as was used for the population distributions. The consumption rates were those used in GENII for the maximum individual and average individual. People living within the 80 km (50 mi) assessment area were assumed to consume only food grown in that area.

Calculational Assumptions. Dose assessments were performed for members of the general public and workers. Dose assessments for members of the public were performed for two different types of receptors considered in this PEIS: a maximally exposed offsite individual and the general population living within 80 km (50 mi) of the facility. It was assumed that the maximally exposed individual was located at a position on the site boundary that would yield the highest impacts during normal operation of a given alternative. If more than one facility was assumed to be operating at a site, the dose to the individual from each facility was calculated. The doses were then summed to give the total dose to the individual. A 80 km (50 mi) population dose was calculated for each operating facility at a site. These doses were then added to give the total population dose at that site.

To estimate the radiological impacts from normal operation of Stockpile Stewardship and Management alternatives, additional assumptions and factors were considered in using GENII:

- No prior deposition of radionuclides on ground surfaces was assumed.
- For the maximally exposed offsite individual, the annual exposure time to the plume and to soil contamination was 0.7 years (NRC 1977b:1.109-68).
- For the population, the annual exposure time to the plume and to soil contamination was 0.5 years (NRC 1977b:1.109-68).
- A semi-infinite/finite plume model was used for air immersion doses. Other pathways evaluated were ground exposure, inhalation, ingestion of food crops and animal products contaminated by either deposition of radioactivity from the air or irrigation, ingestion of fish and other aquatic food raised in contaminated water, exposure through swimming and boating in contaminated surface water, and ingestion of contaminated water. It should be noted that not all pathways were available at every site.
- For atmospheric releases, it was assumed that ground-level releases would occur for all stockpile stewardship and management designated facilities. For site-dependent facilities, reported release heights were used and assumed to be the effective stack height. Use of the effective stack height negates plume rise, thereby making the resultant doses conservative.
- The calculated doses were 50-year committed doses from 1 year of intake.

Resuspension of particulates was not considered because prior calculations of dust loading in the atmosphere showed that this pathway was negligible compared with others. The exposure, uptake, and usage parameters used in the GENII model are provided in tables E.2.2.2–1 through E.2.2.2–4.

Annual average doses to workers for No Action at all DOE sites were based on measured values received by radiation workers during the 1992 time period. The average No Action dose received by a worker at these sites in future years was assumed to remain the same as the annual average during the 1992 period. The total workforce dose in future years was calculated by multiplying the average worker dose by a projected number of future workers.

Doses to workers directly associated with stewardship and management facilities were taken either from data reports prepared by the DOE Complex sites or from occupational dose histories for similar operations. To obtain the total workforce dose at a site with particular stewardship and/or management facilities in operation, the site dose from No Action was added to that from the facilities being evaluated. The average dose to a site worker was then calculated by dividing this dose by the total number of workers at the site. All doses to workers include a component associated with the intake of radioactivity into the body and another component resulting from external exposure to direct radiation.

E.2.2.3 *Health Effects Calculations*

Doses calculated by GENII were used to estimate health effects using the risk estimators presented in section E.2.1.2. The incremental cancer fatalities in the general population and groups of workers due to radiation exposure were therefore estimated by multiplying the collective combined effective dose equivalent by 0.0005 and 0.0004 fatal cancers/person-rem, respectively. In this PEIS, the collective combined effective dose equivalent is the sum of the collective committed effective dose equivalent (internal dose) and the collective effective dose equivalent (external dose), section E.2.1.1.

Although health risk factors are statistical factors, therefore not strictly applicable to individuals, they have been used in the past to estimate the incremental risk to an individual from exposure to radiation. Therefore, the factors of 0.0005 and 0.0004 per rem of individual committed effective dose equivalent for a member of the public and for a worker, respectively, have also been used in this PEIS to calculate the individual's incremental fatal cancer risk from exposure to radiation.

For the public, the health effects expressed in the PEIS are the risk of fatal cancers for the maximally exposed individual and the number of fatal cancers in the 80 km (50 mi) population from exposure to radioactivity released from any site over the 25-year operational period. For workers, the health effects expressed are the risk to the average worker at a site and the number of fatal cancers to all workers at a site from 25 years of site operation.

E.2.3 Normal Operation Releases

This section presents source terms (i.e., radiological releases) to the environment from the normal operation of stockpile management alternatives at each of the applicable proposed sites (Oak Ridge Reservation [ORR], table E.2.3–1; Savannah River Site [SRS], table E.2.3–2; Pantex Plant [Pantex], table E.2.3–3; Los Alamos National Laboratory [LANL], tables E.2.3–4 and E.2.3–5; Lawrence Livermore National Laboratory [LLNL], table E.2.3–6; Nevada Test Site [NTS], table E.2.3–7). These source terms were used in the GENII dose model calculations, which were ultimately used in estimating the most conservative radiological impacts at each site from each of the applicable management alternatives presented in this PEIS. These resultant incremental doses (and associated cancer risks) can be found in sections 4.2.3.9, 4.3.3.9, 4.5.3.9, 4.6.3.9, 4.7.3.9, and 4.9.3.9, respectively, by subtracting the applicable site's No Action impacts from each management alternative's impact total. Only atmospheric releases have been presented because liquid radiological discharges are not expected from any of the alternatives at any of the sites.

TABLE E.2.2.2–1.—*GENII Annual Exposure Parameters to Plumes and Soil Contamination*

Maximally Exposed Individual				General Population			
External Exposure (hours)		Inhalation of Plume		External Exposure (hours)		Inhalation of Plume	
Plume	Soil Contamination	Exposure Time (hours)	Breathing Rate (cc/s)	Plume	Soil Contamination	Exposure Time (hours)	Breathing Rate (cc/s)
6,136	6,136	6,136	270	4,383	4,383	4,383	270

Source: HNUS 1995a.

TABLE E.2.2.2–2.—*GENII Annual Usage Parameters for Consumption of Terrestrial Food*

	Maximally Exposed Individual				General Population			
Food Type	Growing Time (days)	Yield (kg/m^2)	Holdup Time (days)	Consumption Rate (kg/yr)	Growing Time (days)	Yield (kg/m^2)	Holdup Time (days)	Consumption Rate (kg/yr)
Leafy vegetables	90.0	1.5	1.0	30.0	90.0	1.5	14.0	15.0
Root vegetables	90.0	4.0	5.0	220.0	90.0	4.0	14.0	140.0
Fruit	90.0	2.0	5.0	330.0	90.0	2.0	14.0	64.0
Grains/cereals	90.0	0.8	180.0	80.0	90.0	0.8	180.0	72.0

Source: HNUS 1995a.

TABLE E.2.2.2–3.—*GENII Annual Usage Parameters for Consumption of Animal Products*

	Maximally Exposed Individual									
	Human Consumption		Stored Feed				Fresh Forage			
Food Type	Consumption Rate (kg/yr)	Holdup Time (days)	Diet Fraction	Growing Time (days)	Yield (kg/m^3)	Storage Time (days)	Diet Fraction	Growing Time (days)	Yield (kg/m^3)	Storage Time (days)
Beef	80.0	15.0	0.25	90.0	0.80	180.0	0.75	45.0	2.00	100.0
Poultry	18.0	1.0	1.00	90.0	0.80	180.0				
Milk	270.0	1.0	0.25	45.0	2.00	100.0	0.75	30.0	1.50	0.0
Eggs	30.0	1.0	1.00	90.0	0.80	180.0				
	General Population									
Beef	70.0	34.0	0.25	90.0	0.80	180.0	0.75	45.0	2.00	100.0
Poultry	8.5	34.0	1.00	90.0	0.80	180.0				
Milk	230.0	4.0	0.25	45.0	2.00	100.0	0.75	30.0	1.50	0.0
Eggs	20.0	18.0	1.00	90.0	0.80	180.0				

Source: HNUS 1995a.

TABLE E.2.2.2–4.—*GENII Annual Usage Parameters for Aquatic Activities*

	Maximally Exposed Individual			General Population		
Activity	Transit Time to Usage Point (days)	Holdup Time (days)	Usage Rate (per year)	Transit Time to Usage Point (days)	Holdup Time (days)	Usage Rate
Drinking water	0.0	0.0	730 L	0.0	0.0	Site dependent
Swimming	0.0	0.0	100 hours	0.0	0.0	Site dependent
Boating	0.0	0.0	100 hours	0.0	0.0	Site dependent
Shoreline	0.0	0.0	500 hours	0.0	0.0	Site dependent
Ingestion of fish	0.0	0.0	40 kg	0.0	0.0	Site dependent
Ingestion of mollus	0.0	0.0	6.9 kg	0.0	0.0	Site dependent
Ingestion of crusta	0.0	0.0	6.9 kg	0.0	0.0	Site dependent
Ingestion of plants	0.0	0.0	6.9 kg	0.0	0.0	Site dependent

Source: HNUS 1995a.

TABLE E.2.3–1.—*Normal Operational Atmospheric Releases for the Y-12 Downsize Secondary and Case Fabrication Alternative*

Isotope	Release (Ci)
Uranium-235	4.2×10^{-4}
Uranium-238	1.5×10^{-3}

Source: OR MMES 1996j.

TABLE E.2.3–2.—*Normal Operational Atmospheric Releases for the Savannah River Site Pit Fabrication Alternative*

Isotope	Release (Ci)
Plutonium-238	1.9×10^{-8}
Plutonium-239	1.3×10^{-7}
Plutonium-240	3.0×10^{-8}
Plutonium-241	9.0×10^{-7}
Americium-241	2.8×10^{-8}
Total	1.1×10^{-6}

Note: Representative of unclassified isotopic distribution associated with weapons-grade plutonium.
Source: LANL1995g.

TABLE E.2.3–3.—*Normal Operational Atmospheric Releases for the Pantex Plant Downsize Assembly/Disassembly Alternative*

Isotope	Release (Ci)
Hydrogen-3	0.45

Source: PX MH 1995a.

TABLE E.2.3–4.—*Normal Operational Atmospheric Releases for the Los Alamos National Laboratory Pit Fabrication Alternative*

Isotope	Release (Ci)
Plutonium-238	1.9×10^{-8}
Plutonium-239	1.3×10^{-7}
Plutonium-240	3.0×10^{-8}
Plutonium-241	9.0×10^{-7}
Americium-241	2.8×10^{-8}
Total	1.1×10^{-6}

Note: Representative of unclassified complete isotopic distribution associated with weapons-grade plutonium.
Source: LANL 1995g.

TABLE E.2.3–5.—*Normal Operational Atmospheric Releases for the Los Alamos National Laboratory Secondary and Case Fabrication Alternative*

Isotope	Release (Ci)
Uranium-235	4.9×10^{-4}
Uranium-238	1.8×10^{-3}

Source: LANL 1995e.

TABLE E.2.3–6.—*Normal Operational Atmospheric Releases for the Lawrence Livermore National Laboratory Secondary and Case Fabrication Alternative*

Isotope	Release (Ci)
Uranium-235	1.4×10^{-4}
Uranium-238	4.8×10^{-4}

Source: LLNL 1995c.

TABLE E.2.3–7.—*Normal Operational Atmospheric Releases for the Nevada Test Site Assembly/Disassembly Alternative*

Isotope	Release (Ci)
Hydrogen-3	0.45

Source: PX MH 1995a.

E.3 HAZARDOUS CHEMICAL IMPACTS TO HUMAN HEALTH

E.3.1 Background

Two general types of adverse human health effects are assessed for hazardous chemical exposure in this PEIS. These are carcinogenic and noncarcinogenic effects. A *Chemical Health Effects Technical Reference* (TTI 1996b) was developed to assist the risk assessor in the evaluation process. Part I of the Technical Reference contains a table of chemical toxicity profiles which characterizes each chemical in terms of physical properties, potential exposure routes, and the effects on target tissues/organs that might be expected. It is to be used qualitatively by the risk assessor to determine how exposure might occur (exposure route), what tissue or organ system might be impacted (e.g., central nervous system dysfunction, or liver cancer), and whether the chemical might possess other properties affecting its bioavailability in a given matrix (e.g., air, water, or soil). Part II of the Technical Reference contains a table of exposure limits which provides the risk assessor with the necessary information to calculate risk or expected adverse effects should an individual be exposed to a hazardous chemical for a long time at low levels (chronic exposure) or to higher concentrations for a short-term (acute) exposure. Where a dose effect calculation is required (milligram [mg]/kg/day), the reference dose is applicable, and where an inhalation concentration effect is required, the reference concentration (i.e., RfC in mg/m^3) is applicable for chronic exposures. The permissible exposure limit values, which regulate worker exposures over 8-hour periods, determine the concentration allowed for occupational exposures that would be without adverse acute effects. Other values, such as the threshold limit value (TLV), are presented because they are prepared by the American Conference of Governmental Industrial Hygienists for guidance on exposures of 8-hour periods, and can be used to augment permissible exposure limits or serve as exposure levels in the absence of a permissible exposure limit. All currently regulated chemicals associated with each site and every hazardous chemical are presented in the *Chemical Health Effects Technical Reference*.

It was assumed that under normal operation conditions members of the public would only receive chronic exposures at low levels in the form of air emissions from a centrally located source term at each site. Since hazardous chemicals are not released into surface or groundwaters or onto soil, inhalation is assumed to be the only route of exposure. However, all chemical quantities are accounted for as air emissions which are several orders of magnitude greater than all other possible routes combined. It was further assumed that the maximally exposed individual member of the public would be at the site boundary, and this assumption was used when calculating all public exposures, which under normal operating conditions are expected to be chronic and at very low levels. For worker exposures to hazardous chemicals, it was assumed that individuals were exposed only to low air emission concentrations during an 8-hour day for a 40-hour week for a maximum working lifetime of 40 years. The point of exposure chosen was 100 meters from a centrally located source term, since the precise placement of source terms onsite could not be made. Further, it could not be determined where the involved and non-

involved workers would be relative to the emission sources.

For every site involved in the analysis, hazard indexes (HIs) were calculated for every alternative action relative to the site. The exposure concentrations of hazardous chemicals for the public and the onsite workers were developed using the industrial source complex short-term model recommended for point, area, and volume sources. This model, which estimates dispersion of emissions from these sources, has been field-tested and recommended by the EPA. The modeled concentrations were compared to the reference concentration and permissible exposure limit values unique to each chemical to yield hazard quotients (HQs) for the public and onsite workers, respectively. The HQs were summed to give the HIs for each alternative action at each site, as well as total HIs (i.e., No Action HI + alternative HI). For cancer risk estimation, the inhaled concentrations were converted to doses in mg/kg/day, which were then multiplied by the slope factors unique to each identified carcinogen. The risks for all carcinogens associated with each alternative (incremental risk) at each site were summed, and the No Action cancer risk for each site was added in order to show the total risk should that alternative action be implemented at a given site. This PEIS does not purport to provide the level of detail needed to go beyond a conservative screening process for hazardous chemicals. As such, the analysis in this PEIS for the No Action alternative should not be relied upon as a basis for judging the sites as having a hazardous chemical health concern.

E.3.2 Chemical Toxicity Profiles

Part I of the *Chemical Health Effects Technical Reference* provides the pertinent facts about each chemical that is included in the risk assessment of this PEIS. This reference includes the chemical abstracts service number, which aids in a search for information available on any specific chemical and ensures a positive identity regardless of which name or synonym is used. It also contains physical information (i.e., solubility, vapor pressure, and flammability), as well as incompatibility data that is useful in determining whether a hazard might exist and the nature of the hazard. The route of exposure, target organs/tissues, and carcinogenicity provide an abbreviated summary on how individuals may get exposed, what body functions could be affected, and whether chronic exposure could lead to increased cancer incidence in an exposed population.

E.3.3 Regulated Exposure Limits

Hazardous chemicals are regulated by various agencies in order to provide protection to the public (EPA regulated) and to workers (Occupational Safety and Health Administration [OSHA]), while others (National Institute for Occupational Safety and Health and the American Conference of Governmental Industrial Hygienists) provide guidelines. The reference doses and reference concentrations set by EPA represent exposure limits for long-term (chronic) exposure at low doses and concentrations, respectively, that can be considered safe from adverse noncancer effects. The permissible exposure limit represents concentration levels set by OSHA that are safe for 8-hour exposures without causing noncancer adverse effects. The slope factor or the unit risk is used to convert the daily uptake of a carcinogenic chemical averaged over a lifetime to the incremental risk of an individual developing cancer. Part II of the *Chemical Health Effects Technical Reference* presents the information on exposure limits used to develop HQs for each of the hazardous chemicals and the HIs derived from their summation and the slope factors used to calculate cancer risk for each chemical at the exposure concentrations identified at the various sites or associated with a proposed alternative action.

E.3.4 Hazardous Chemical Risks/Effects Calculations

Tables E.3.4–1 through E.3.4–30 show the chemicals associated with the various activities and the various sites considered for each alternative. The increment added by each activity to the site is totalled to show how much the risk at the site would increase should that alternative be implemented. Calculations used to derive the hazard indices for workers and for the public are presented as footnotes to each of the appendix tables. In addition, the slope factor used to calculate the cancer risk for workers and for the public are presented as footnotes in the appendix tables, and the footnotes to the tables show how the cancer risk was performed.

TABLE E.3.4–1.—*Risk Assessments from Exposure to Hazardous Chemicals from No Action at Oak Ridge Reservation*

	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Acetic acid	0.6125	25	None	$3.30x10^{-8}$	$1.98x10^{-5}$	$5.39x10^{-8}$	$7.93x10^{-7}$	0	0
Carbon monoxide	1.35	55	None	$3.14x10^{-3}$	1.88	$2.32x10^{-3}$	$3.42x10^{-2}$	0	0
Chlorine	0.35	3	None	$5.78x10^{-5}$	$3.47x10^{-2}$	$1.65x10^{-4}$	$1.16x10^{-2}$	0	0
Hydrogen chloride	0.0070	7.0	None	$2.12x10^{-4}$	$1.27x10^{-1}$	$3.03x10^{-2}$	$1.82x10^{-2}$	0	0
Hydrogen fluoride	0.21	2.49	None	$2.31x10^{-6}$	$1.39x10^{-3}$	$1.10x10^{-5}$	$5.57x10^{-4}$	0	0
Methyl alcohol	1.75	260	None	$8.72x10^{-4}$	$5.23x10^{-1}$	$4.98x10^{-4}$	$2.01x10^{-3}$	0	0
Nitric acid	0.1225	5	None	$3.14x10^{-4}$	$1.88x10^{-1}$	$2.56x10^{-3}$	$3.76x10^{-2}$	0	0
Sulfuric acid	0.0245	1	None	$8.25x10^{-5}$	$4.95x10^{-2}$	$3.37x10^{-3}$	$4.95x10^{-2}$	0	0
1,1,1-Trichloroethane (TCA)	1.000	1,900	None	$7.26x10^{-6}$	$4.36x10^{-3}$	$5.93x10^{-5}$	$2.29x10^{-6}$	0	0
Volatile organic compounds (toluene)	0.4	766	None	$1.22x10^{-4}$	$7.33x10^{-2}$	$3.05x10^{-4}$	$9.57x10^{-5}$	0	0
Hazard Index[g]						$3.95x10^{-2}$	$1.54x10^{-1}$		
Total Cancer Risk[h]								0	0

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.
[b] MEI - maximally exposed individual of the public.
[c] Hazard Quotient for MEI - boundary annual emissions/reference concentration (RfC).
[d] Hazard Quotient for workers - 100-m, 8-hr emissions/permissible exposure limit (PEL).
[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).
[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).
[g] Hazard index - sum of individual hazard quotients.
[h] Total cancer risk - sum of individual cancer risks.

Source: OR LMES 1995e.

TABLE E.3.4–2.—*Risk Assessments from Exposure to Hazardous Chemicals from Downsize/Consolidate Secondary and Case Fabrication at Oak Ridge Reservation*

Chemical	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Carbon monoxide	1.35	55	None	4.85×10^{-4}	2.91×10^{-1}	3.59×10^{-4}	5.30×10^{-3}	0	0
Chlorine	0.35	3	None	8.91×10^{-6}	5.35×10^{-3}	2.55×10^{-5}	1.78×10^{-3}	0	0
Hydrogen chloride	0.0070	7.0	None	3.17×10^{-4}	1.90×10^{-1}	4.53×10^{-2}	2.72×10^{-2}	0	0
Methyl alcohol	1.75	260	None	9.57×10^{-4}	5.75×10^{-1}	5.47×10^{-4}	2.21×10^{-3}	0	0
Nitric acid	0.1225	5	None	4.62×10^{-4}	2.77×10^{-1}	3.77×10^{-3}	5.65×10^{-2}	0	0
Ozone	0.0049	0.2	None	4.62×10^{-6}	2.77×10^{-3}	9.43×10^{-4}	1.39×10^{-2}	0	0
Sulfuric acid	0.0245	1	None	1.19×10^{-4}	7.13×10^{-2}	4.85×10^{-3}	7.13×10^{-2}	0	0
Uranium-235	0.0105	0.25	None	6.60×10^{-9}	3.96×10^{-6}	6.29×10^{-7}	1.59×10^{-5}	0	0
Uranium-238	0.0105	0.25	None	1.32×10^{-7}	7.93×10^{-5}	1.22×10^{-5}	3.17×10^{-4}	0	0
Volatile organic compounds (toluene)	0.4	766	None	7.92×10^{-5}	4.76×10^{-2}	1.98×10^{-4}	6.21×10^{-5}	0	0
Hazard Index[g]						5.60×10^{-2}	1.78×10^{-1}		
Total Cancer Risk[h]								0	0

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI - maximally exposed individual of the public.

[c] Hazard Quotient for MEI - boundary annual emissions/reference concentration (RfC).

[d] Hazard Quotient for workers - 100-m, 8-hr emissions/permissible exposure limit (PEL).

[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).

[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).

[g] Hazard index - sum of individual hazard quotients.

[h] Total cancer risk - sum of individual cancer risks.

Source: OR MMES 1996j.

TABLE E.3.4–3.—*Risk Assessments from Exposure to Hazardous Chemicals from Phaseout of Secondary and Case Fabrication at Oak Ridge Reservation*

	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Carbon monoxide	1.35	55	None	$1.36x10^{-2}$	2.60	$1.01x10^{-2}$	$4.73x10^{-2}$	0	0
Chlorine	0.35	3	None	$2.63x10^{-4}$	$5.04x10^{-2}$	$7.51x10^{-4}$	$1.68x10^{-2}$	0	0
Hydrogen chloride	0.0070	7.0	None	$1.12x10^{-4}$	$2.16x10^{-2}$	$1.61x10^{-2}$	$3.08x10^{-3}$	0	0
Methyl alcohol	1.75	260	None	$4.30x10^{-4}$	$8.24x10^{-2}$	$2.46x10^{-4}$	$3.17x10^{-4}$	0	0
Nitric acid	0.1225	5	None	$1.65x10^{-4}$	$3.17x10^{-2}$	$1.35x10^{-3}$	$6.34x10^{-3}$	0	0
Sulfuric acid	0.0245	1	None	$5.29x10^{-5}$	$1.01x10^{-2}$	$2.16x10^{-3}$	$1.01x10^{-2}$	0	0
1,1,1-Trichloroethane (TCA)	0.1225	1,900	None	$3.31x10^{-6}$	$6.34x10^{-4}$	$2.70x10^{-5}$	$3.34x10^{-7}$	0	0
Volatile organic compounds (toluene)	0.4	766	None	$3.80x10^{-4}$	$7.29x10^{-2}$	$9.51x10^{-4}$	$9.52x10^{-5}$	0	0
Hazard Index[g]						$3.16x10^{-2}$	$8.41x10^{-2}$		
Total Cancer Risk[h]								0	0

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI - maximally exposed individual of the public.

[c] Hazard Quotient for MEI - boundary annual emissions/reference concentration (RfC).

[d] Hazard Quotient for workers - 100-m, 8-hr emissions/permissible exposure limit (PEL).

[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).

[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).

[g] Hazard index - sum of individual hazard quotients.

[h] Total cancer risk - sum of individual cancer risks.

Source: OR LMES 1996i.

TABLE E.3.4–4.—*Risk Assessments from Exposure to Hazardous Chemicals from No Action at Savannah River Site*

Chemical	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Benzene	0.0796	3.25	0.029	$1.25x10^{-6}$	$1.37x10^{-2}$	$1.57x10^{-5}$	$4.2x10^{-3}$	$1.04x10^{-8}$	$1.53x10^{-5}$
Benzene	0.0796	3.25	0.029	$1.23x10^{-5}$	$1.35x10^{-1}$	$1.55x10^{-4}$	$4.15x10^{-2}$	$1.02x10^{-7}$	$1.51x10^{-4}$
Carbon Monoxide	1.35	55	None	$5.41x10^{-3}$	$5.91x10^{-1}$	$4.01x10^{-3}$	1.07	0	0
Chlorine	0.35	3	None	$9.27x10^{-9}$	$1.01x10^{-4}$	$2.65x10^{-8}$	$3.37x10^{-5}$	0	0
Chloroform	0.035	240	0.0061	$4.79x10^{-6}$	$5.24x10^{-2}$	$1.37x10^{-4}$	$2.18x10^{-4}$	$8.36x10^{-9}$	$1.24x10^{-5}$
Cobalt	0.00245	0.1	None	$7.46x10^{-9}$	$8.15x10^{-5}$	$3.05x10^{-6}$	$8.15x10^{-4}$	0	0
Hydrogen Fluoride	0.21	2.49	None	$4.29x10^{-8}$	$4.69x10^{-4}$	$2.04x10^{-7}$	$1.88x10^{-4}$	0	0
Hydrogen Fluoride	0.21	2.49	None	$8.39x10^{-12}$	$9.16x10^{-8}$	$3.99x10^{-11}$	$3.68x10^{-8}$	0	0
Mercury	0.0003	0.1	None	$5.17x10^{-8}$	$5.65x10^{-4}$	$1.72x10^{-4}$	$5.65x10^{-3}$	0	0
Mercury (vapor)	0.0003	0.1	None	$1.89x10^{-7}$	$2.06x10^{-3}$	$6.29x10^{-4}$	$2.06x10^{-2}$	0	0
Mercury oxide	0.0003	0.1	None	$6.36x10^{-18}$	$6.95x10^{-14}$	$2.12x10^{-14}$	$6.95x10^{-13}$	0	0
Nickel compounds	0.0245	1	0.84	$3.16x10^{-16}$	$3.45x10^{-12}$	$1.29x10^{-14}$	$3.45x10^{-12}$	$7.6x10^{-17}$	$1.12x10^{-13}$
Nickel (vapor and compounds)	0.0245	1	0.84	$4.31x10^{-8}$	$4.7x10^{-4}$	$1.76x10^{-6}$	$4.7x10^{-4}$	$1.03x10^{-8}$	$1.53x10^{-5}$
Nitric acid	0.1225	5	None	$3.73x10^{-6}$	$4.07x10^{-2}$	$3.04x10^{-5}$	$8.15x10^{-3}$	0	0
Phosphoric acid	0.0245	1	None	$1.5x10^{-7}$	$1.63x10^{-3}$	$6.11x10^{-6}$	$1.63x10^{-3}$	0	0
Hazard Index[g]						$5.16x10^{-3}$	1.16		
Total Cancer Risk[h]								$1.31x10^{-7}$	$1.94x10^{-4}$

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI - maximally exposed individual of the public.

[c] Hazard Quotient for MEI - boundary annual emissions/reference concentration (RfC).

[d] Hazard Quotient for workers - 100-m, 8-hr emissions/permissible exposure limit (PEL).

[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).

[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).

[g] Hazard index - sum of individual hazard quotients.

[h] Total cancer risk - sum of individual cancer risks.

Source: SRS 1995a:2.

TABLE E.3.4–5.—*Risk Assessments from Exposure to Hazardous Chemicals from Pit Fabrication at Savannah River Site*

	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Carbon monoxide	1.35	55	None	1.06×10^{-6}	1.55×10^{-2}	7.82×10^{-7}	2.10×10^{-4}	0	0
Carbon dioxide	221	9,000	None	6.99×10^{-5}	7.64×10^{-1}	3.16×10^{-7}	8.48×10^{-5}	0	0
Volatile organic compounds (toluene)	0.4	766	None	2.94×10^{-7}	3.21×10^{-3}	7.34×10^{-7}	4.19×10^{-6}	0	0
Hazard Index[g]						1.83×10^{-6}	2.99×10^{-4}		
Total Cancer Risk[h]								0	0

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI - maximally exposed individual of the public.

[c] Hazard Quotient for MEI - boundary annual emissions/reference concentration (RfC).

[d] Hazard Quotient for workers - 100-m, 8-hr emissions/permissible exposure limit (PEL).

[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).

[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).

[g] Hazard index - sum of individual hazard quotients.

[h] Total cancer risk - sum of individual cancer risks.

Source: WSRC 1995c.

TABLE E.3.4–6.—*Risk Assessments from Exposure to Hazardous Chemicals from No Action at Kansas City Plant*

Chemical	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Acetone	0.35	2,400	None	$1.10x10^{-4}$	$5.71x10^{-3}$	$3.63x10^{-4}$	$2.38x10^{-6}$	0	0
Carbon monoxide	1.35	55	None	$5.31x10^{-3}$	$2.77x10^{-1}$	$3.93x10^{-3}$	$5.03x10^{-3}$	0	0
Chromium (trivalent)	3.5	0.05	None	$3.66x10^{-6}$	$1.90x10^{-4}$	$1.04x10^{-6}$	$3.81x10^{-3}$	0	0
Cyanide (hydrogen cyanide)	0.07	11	None	$4.11x10^{-6}$	$2.14x10^{-4}$	$5.88x10^{-5}$	$1.95x10^{-5}$	0	0
Ethyl benzene	1	435	None	$2.19x10^{-5}$	$1.14x10^{-3}$	$2.19x10^{-5}$	$2.63x10^{-6}$	0	0
Formaldehyde	0.7	0.9375	None	$3.66x10^{-6}$	$1.90x10^{-4}$	$5.22x10^{-6}$	$2.03x10^{-4}$	0	0
Hydrogen chloride	0.007	7	None	$1.10x10^{-5}$	$5.71x10^{-4}$	$1.57x10^{-3}$	$8.16x10^{-5}$	0	0
Isopropyl alcohol	24.01	980	None	$6.22x10^{-4}$	$3.24x10^{-2}$	$2.59x10^{-5}$	$3.30x10^{-5}$	0	0
Methyl alcohol	1.75	260	None	$3.66x10^{-6}$	$1.90x10^{-4}$	$2.09x10^{-6}$	$7.32x10^{-7}$	0	0
Methyl ethyl ketone (MEK)	1	590	None	$6.22x10^{-5}$	$3.24x10^{-3}$	$6.22x10^{-5}$	$5.49x10^{-6}$	0	0
Methyl isobutyl ketone (MIBK)	0.28	410	None	$1.10x10^{-5}$	$5.71x10^{-4}$	$3.92x10^{-5}$	$1.39x10^{-6}$	0	0
Perchloroethylene	0.035	689	0.002	$1.17x10^{-4}$	$6.09x10^{-3}$	$3.34x10^{-3}$	$8.84x10^{-6}$	$6.69x10^{-8}$	$4.72x10^{-7}$
Toluene	0.4	766	None	$1.79x10^{-4}$	$9.33x10^{-3}$	$4.48x10^{-4}$	$1.22x10^{-5}$	0	0
Toluene-2,4-diisocyanate (TDI)	0.00343	0.14	None	$3.66x10^{-6}$	$1.90x10^{-4}$	$1.07x10^{-3}$	$1.36x10^{-3}$	0	0
1,1,1-Trichloroethane (TCA)	0.1225	1,900	None	$1.46x10^{-5}$	$7.62x10^{-4}$	$1.19x10^{-4}$	$4.01x10^{-7}$	0	0
Trichloroethylene (TCE)	13.377	546	0.006	$6.22x10^{-4}$	$3.24x10^{-2}$	$4.65x10^{-5}$	$5.93x10^{-5}$	$1.07x10^{-6}$	$7.52x10^{-6}$
Volatile organic compounds (toluene)	0.4	766	None	$3.20x10^{-3}$	$1.67x10^{-1}$	$8.00x10^{-3}$	$2.18x10^{-4}$	0	0
Xylene	7	434	None	$1.02x10^{-4}$	$5.33x10^{-3}$	$1.46x10^{-5}$	$1.23x10^{-5}$	0	0
Hazard Index[g]						$1.90x10^{-2}$	$1.08x10^{-2}$		
Total Cancer Risk[h]								$1.13x10^{-6}$	$7.99x10^{-6}$

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI - maximally exposed individual of the public.

[c] Hazard Quotient for MEI - boundary annual emissions/reference concentration (RfC).

[d] Hazard Quotient for workers - 100-m, 8-hr emissions/permissible exposure limit (PEL).

[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).

[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).

[g] Hazard index - sum of individual hazard quotients.

[h] Total cancer risk - sum of individual cancer risks.

Source: KCP 1995a:1.

TABLE E.3.4–7.—*Risk Assessments from Exposure to Hazardous Chemicals from Nonnuclear Fabrication at Kansas City Plant*

	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Acetone	0.35	2,400	None	$1.19x10^{-4}$	$6.07x10^{-3}$	$3.33x10^{-4}$	$2.53x10^{-6}$	0	0
Isopropyl alcohol	24.01	980	None	$1.05x10^{-3}$	$5.48x10^{-2}$	$4.38x10^{-5}$	$5.59x10^{-5}$	0	0
Methyl ethyl ketone (MEK)	1	590	None	$7.08x10^{-5}$	$3.69x10^{-3}$	$7.08x10^{-5}$	$6.25x10^{-6}$	0	0
Toluene	0.4	766	None	$2.00x10^{-4}$	$1.04x10^{-2}$	$5.00x10^{-4}$	$1.36x10^{-5}$	0	0
Trichloroethylene (TCE)	13.377	546	0.006	$9.61x10^{-4}$	$5.00x10^{-2}$	$2.18x10^{-5}$	$9.17x10^{-5}$	$1.65x10^{-6}$	$1.16x10^{-5}$
Hazard Index[g]						$1.02x10^{-3}$	$1.70x10^{-4}$		
Total Cancer Risk[h]								$1.65x10^{-6}$	$1.16x10^{-5}$

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.
[b] MEI - maximally exposed individual of the public.
[c] Hazard Quotient for MEI - boundary annual emissions/reference concentration (RfC).
[d] Hazard Quotient for workers - 100-m, 8-hr emissions/permissible exposure limit (PEL).
[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).
[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).
[g] Hazard index - sum of individual hazard quotients.
[h] Total cancer risk - sum of individual cancer risks.
Source: KC ASI 1995a.

TABLE E.3.4–8.—*Risk Assessments from Exposure to Hazardous Chemicals from Phaseout of Nonnuclear Fabrication at Kansas City Plant*

	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
None	0	0	None	0	0	0	0	0	0
Hazard Index[g]						0	0		
Total Cancer Risk[h]								0	0

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI - maximally exposed individual of the public.

[c] Hazard Quotient for MEI - boundary annual emissions/reference concentration (RfC).

[d] Hazard Quotient for workers - 100-m, 8-hr emissions/permissible exposure limit (PEL).

[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).

[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).

[g] Hazard index - sum of individual hazard quotients.

[h] Total cancer risk - sum of individual cancer risks.

Source: KC ASI 1995a.

TABLE E.3.4–9.—*Risk Assessments from Exposure to Hazardous Chemicals from No Action at Pantex Plant* [Page 1 of 2]

	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient[a,b]		Cancer Risk[c,d]	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[e] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b]	Worker 100 m 8 hours[f]	Boundary Annual MEI[b]	Worker 100 m 8 hours
Benzene[f]	0.0796	3.25	None	8.53×10^{-7}	2.56×10^{-4}	2.44×10^{-6}	4.05×10^{-6}	0	0
Carbon disulfide	0.35	63.2	None	4.91×10^{-7}	1.48×10^{-4}	2.01×10^{-4}	2.31×10^{-6}	7.45×10^{-9}	3.03×10^{-7}
Carbon tetrachloride	0.00245	63.9	0.053	5.63×10^{-8}	1.69×10^{-5}	8.05×10^{-7}	4.83×10^{-8}	0	0
Chlorobenzene	0.07	350	None	7.17×10^{-7}	2.15×10^{-4}	7.17×10^{-7}	1.13×10^{-7}	0	0
1,1,1-Chloroethane (Trichloroethane) (TCA)	1	1,900	None						
Chromium (hexavalent)[f]	0.0175	1	None						
Cresol	0.539	22	None	1.57×10^{-9}	4.72×10^{-7}	2.92×10^{-9}	2.15×10^{-8}	0	0
Cresylic acid	0.539	22	None	1.57×10^{-9}	4.72×10^{-7}	2.92×10^{-9}	2.15×10^{-8}	0	0
Dibenzofuran	None	None	None	2.29×10^{-9}	6.87×10^{-7}	None	None	0	0
Ester glycol ethers (2-ethoxyethanol)	0.2	740	None	2.70×10^{-8}	8.12×10^{-6}	1.35×10^{-7}	1.10×10^{-8}	0	0
Ethyl benzene	1	435	None	4.78×10^{-8}	1.43×10^{-5}	4.78×10^{-8}	3.30×10^{-8}	0	0
Ethylene dichloride	5.03	205.5	0.091	4.19×10^{-8}	1.26×10^{-5}	8.33×10^{-9}	6.12×10^{-8}	1.09×10^{-9}	4.43×10^{-8}
Formaldehyde[f]	0.7	0.9375	0.045						
Hydrogen chloride	0.007	7	None	3.49×10^{-5}	1.05×10^{-2}	4.98×10^{-3}	1.50×10^{-3}	0	0
Hydrogen fluoride	0.21	2.49	None	3.71×10^{-5}	1.11×10^{-2}	1.77×10^{-4}	4.47×10^{-3}	0	0
Ketones (acetone)	0.35	2,400	None	8.72×10^{-9}	2.62×10^{-6}	2.49×10^{-8}	1.09×10^{-9}	0	0
Methyl alcohol	1.75	260	None	3.45×10^{-5}	1.04×10^{-2}	1.97×10^{-5}	3.98×10^{-5}	0	0
Methyl ethyl ketone (MEK)	1	590	None	2.23×10^{-4}	6.69×10^{-2}	2.23×10^{-4}	1.13×10^{-4}	0	0
Methylene chloride[f]	3	1,765	0.075						
Methyl isobutyl ketone (MIBK)	0.28	410	None	1.94×10^{-8}	5.84×10^{-6}	6.94×10^{-8}	1.42×10^{-8}	0	0
Naphthalene	0.014	50	None	1.29×10^{-8}	3.87×10^{-6}	9.19×10^{-7}	7.73×10^{-8}	0	0
Nickel	0.0245	1	0.84	5.15×10^{-9}	1.55×10^{-6}	2.10×10^{-7}	1.55×10^{-6}	1.24×10^{-9}	5.03×10^{-8}
Nitrobenzene	0.00175	5	None	1.37×10^{-9}	4.72×10^{-7}	8.00×10^{-7}	9.45×10^{-8}	0	0
2-Nitropropane[f]	0.02	90	0.2						

TABLE E.3.4–9.—*Risk Assessments from Exposure to Hazardous Chemicals from No Action at Pantex Plant* [Page 2 of 2]

Chemical	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient[a,b]		Cancer Risk[c,d]	
	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[e] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b]	Worker 100 m 8 hours[f]	Boundary Annual MEI[b]	Worker 100 m 8 hours
Phenol	2.1	19	None	$7.03x10^{-8}$	$2.11x10^{-5}$	$3.35x10^{-8}$	$1.11x10^{-6}$	0	0
Tetrachloroethylene	0.035	689	0.002	$2.03x10^{-7}$	$6.09x10^{-5}$	$5.80x10^{-6}$	$8.85x10^{-8}$	$1.16x10^{-10}$	$4.72x10^{-9}$
Toluene	0.4	766	None	$1.47x10^{-5}$	$4.41x10^{-3}$	$3.67x10^{-5}$	$5.76x10^{-6}$	0	0
1,1,2-Trichloroethane[f]	1.014	45	None						
Trichloroethene (trichloroethylene, TCE)	13.377	546	0.006	$6.15x10^{-7}$	$1.85x10^{-4}$	$4.60x10^{-8}$	$3.38x10^{-7}$	$1.06x10^{-9}$	$4.29x10^{-8}$
Xylene	7	435	None	$7.0x10^{-6}$	$2.1x10^{-3}$	$1x10^{-6}$	$4.84x10^{-6}$	0	0
Hazard Index[g]						$5.65x10^{-3}$	$6.14x10^{-3}$		
Total Cancer Risk[h]								$1.09x10^{-8}$	$4.45x10^{-7}$

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI - maximally exposed individual of the public.

[c] Hazard Quotient for MEI - boundary annual emissions/reference concentration (RfC).

[d] Hazard Quotient for workers - 100-m, 8-hr emissions/permissible exposure limit (PEL).

[e] Cancer risk for MEI - (emissions concentrations) x (0.237 [fraction of year exposed]]) x (o.572 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).

[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).

[g] The following chemicals have not been subjected to hazard quotient or cancer risk analysis. They were contained in a list of chemicals used at Pantex for reporting to the State of Texas under SARA Title III. In all cases, the emissions were estimated using product throughput for 1993. They do not represent employee exposure. Therefore, the chemicals remain listed, but are not included in calculations for hazard index and cancer risk to the public and the onsite worker.

[h] Hazard index - sum of individual hazard quotients.

Source: PX 1995a:4.

TABLE E.3.4–10.—*Risk Assessments from Exposure to Hazardous Chemicals from Assembly/Disassembly and High Explosives Fabrication at Pantex Plant* [Page 1 of 2]

	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Acetonitrile	0.021	70	None	$1.43x10^{-8}$	$4.29x10^{-6}$	$6.81x10^{-7}$	$6.14x10^{-8}$	0	0
Aldehydes (formaldehyde)	0.7	0.9375	None	$6.43x10^{-8}$	$1.93x10^{-5}$	$9.19x10^{-8}$	$2.06x10^{-5}$	0	0
Ammonia	0.1	35	None	$5.72x10^{-10}$	$1.72x10^{-7}$	$5.72x10^{-9}$	$4.91x10^{-9}$	0	0
Benzene	0.0796	3.25	0.029	$9.44x10^{-8}$	$2.83x10^{-5}$	$1.19x10^{-6}$	$8.72x10^{-6}$	$7.83x10^{-10}$	$3.18x10^{-8}$
Carbon monoxide	1.35	55	None	$1.30x10^{-5}$	$3.91x10^{-3}$	$9.64x10^{-6}$	$7.11x10^{-5}$	0	0
Cresylic acid	0.539	22	None	$4.29x10^{-11}$	$1.29x10^{-8}$	$7.96x10^{-11}$	$6.86x10^{-10}$	0	0
Cyclohexane	25.725	1,050	None	$5.43x10^{-8}$	$1.63x10^{-5}$	$2.11x10^{-10}$	$1.55x10^{-8}$	0	0
1,2-Dichloroethane (ethylene dichloride)	10.069	411	0.091	$1.00x10^{-9}$	$3.01x10^{-7}$	$9.94x10^{-11}$	$7.32x10^{-10}$	$2.60x10^{-11}$	$1.06x10^{-9}$
Dimethylformamide (DMF)	0.03	30	None	$2.86x10^{-10}$	$8.59x10^{-8}$	$9.53x10^{-8}$	$2.86x10^{-9}$	0	0
Dioxane	8.82	360	0.011	$1.29x10^{-9}$	$3.87x10^{-7}$	$1.46x10^{-9}$	$1.07x10^{-9}$	$4.05x10^{-12}$	$1.65x10^{-10}$
Hexane	0.2	1,800	None	$2.86x10^{-9}$	$8.59x10^{-7}$	$1.43x10^{-8}$	$4.77x10^{-10}$	0	0
Hydrogen chloride	0.007	7	None	$1.00x10^{-7}$	$3.01x10^{-5}$	$1.43x10^{-6}$	$4.29x10^{-6}$	0	0
Hydrogen fluoride	0.21	2.49	None	$1.43x10^{-7}$	$4.29x10^{-5}$	$6.81x10^{-7}$	$1.72x10^{-5}$	0	0
Mercury (vapor)	0.0003	0.1	None	$5.72x10^{-16}$	$1.72x10^{-13}$	$1.91x10^{-12}$	$1.72x10^{-12}$	0	0
Methyl alcohol	1.75	260	None	$8.58x10^{-8}$	$2.58x10^{-5}$	$4.90x10^{-8}$	$9.91x10^{-8}$	0	0

TABLE E.3.4–10.—*Risk Assessments from Exposure to Hazardous Chemicals from Assembly/Disassembly and High Explosives Fabrication at Pantex Plant* [Page 2 of 2]

Chemical	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Methyl ethyl ketone (MEK)	1	590	None	1.10×10^{-5}	3.31×10^{-3}	1.10×10^{-5}	5.61×10^{-6}	0	0
Toluene	0.4	766	None	3.00×10^{-7}	9.02×10^{-4}	7.51×10^{-7}	1.18×10^{-7}	0	0
1,1,1-Trichloroethane (TCA)	0.1225	1,900	None	1.72×10^{-8}	5.15×10^{-6}	1.40×10^{-7}	2.71×10^{-9}	0	0
Trichloroethylene (TCE)	13.377	546	0.006	1.43×10^{-8}	4.29×10^{-6}	1.07×10^{-9}	7.87×10^{-9}	2.45×10^{-11}	9.97×10^{-10}
Volatile organic compounds (toluene)	0.4	766	None	3.86×10^{-6}	1.16×10^{-3}	9.65×10^{-6}	1.51×10^{-6}	0	0
Xylene	7	434	None	2.43×10^{-7}	7.30×10^{-4}	3.47×10^{-8}	1.68×10^{-7}	0	0
Hazard Index[g]						4.82×10^{-5}	1.30×10^{-4}		
Total Cancer Risk[h]								8.37×10^{-10}	3.40×10^{-8}

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI - maximally exposed individual of the public.

[c] Hazard Quotient for MEI - boundary annual emissions/reference concentration (RfC).

[d] Hazard Quotient for workers - 100-m, 8-hr emissions/permissible exposure limit (PEL).

[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).

[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).

[g] Hazard Index - Sum of Individual Hazard Quotients.

[h] Total Cancer Risk - Sum of Individual Cancer Risks.

Source: PX DOE 1995e; PX MH 1995a.

TABLE E.3.4–11.—*Risk Assessments from Exposure to Hazardous Chemicals from Downsize Assembly/Disassembly at Pantex Plant*
[Page 1 of 2]

	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Acetonitrile	0.021	70	None	$7.15x10^{-8}$	$2.15x10^{-5}$	$3.40x10^{-6}$	$3.07x10^{-7}$	0	0
Aldehydes (formaldehyde)	0.7	0.9375	None	$1.43x10^{-7}$	$4.29x10^{-5}$	$2.04x10^{-7}$	$4.58x10^{-5}$	0	0
Ammonia	0.1	35	None	$1.43x10^{-5}$	$4.29x10^{-3}$	$1.43x10^{-4}$	$1.23x10^{-4}$	0	0
Benzene	0.0796	3.25	0.029	$1.43x10^{-8}$	$4.29x10^{-6}$	$1.80x10^{-7}$	$1.32x10^{-6}$	$1.19x10^{-10}$	$4.82x10^{-9}$
Bisphenol-alpha-epichlorohydrin (epich)	0.1225	5	None	$1.43x10^{-8}$	$4.29x10^{-6}$	$1.17x10^{-7}$	$8.59x10^{-7}$	0	0
n-Butyl glyucidyl ether (BGE)	6.615	270	None	$1.43x10^{-8}$	$4.29x10^{-6}$	$2.16x10^{-9}$	$1.59x10^{-8}$	0	0
Carbon monoxide	1.35	55	None	$1.72x10^{-4}$	$5.15x10^{-2}$	$1.27x10^{-4}$	$9.37x10^{-4}$	0	0
Chloroform	0.035	240	0.0061	$1.43x10^{-8}$	$4.29x10^{-6}$	$4.09x10^{-7}$	$1.79x10^{-8}$	$2.49x10^{-11}$	$1.01x10^{-9}$
Cresylic acid	0.539	22	None	$1.43x10^{-8}$	$4.29x10^{-6}$	$2.65x10^{-8}$	$1.95x10^{-7}$	0	0
Cyclohexane	25.725	1,050	None	$1.43x10^{-8}$	$4.29x10^{-6}$	$5.56x10^{-10}$	$4.09x10^{-9}$	0	0
Dibutyl phthalate	0.35	5	None	$1.72x10^{-7}$	$5.15x10^{-5}$	$4.90x10^{-7}$	$1.03x10^{-5}$	0	0
1,2-Dichloroethane (ethylene dichloride)	10.069	411	0.091	$1.43x10^{-8}$	4.29x10	1.42x10	1.05x10	$3.72x10^{-10}$	$1.51x10^{-8}$
Dioxane	8.82	360	0.011	$1.43x10^{-8}$	$4.29x10^{-6}$	$1.62x10^{-9}$	$1.19x10^{-8}$	$4.50x10^{-11}$	$1.83x10^{-9}$
Dimethylformamide (DMF)	0.03	30	None	$1.43x10^{-8}$	$4.29x10^{-6}$	$4.77x10^{-7}$	$1.43x10^{-7}$	0	0
Ferric ferrocyanide	0.0245	1	None	$1.43x10^{-8}$	$4.29x10^{-6}$	$5.84x10^{-7}$	$4.29x10^{-6}$	0	0
Hexane	0.2	1,800	None	$1.43x10^{-8}$	$4.29x10^{-6}$	$7.15x10^{-8}$	$2.39x10^{-9}$	0	0
Hydrogen chloride	0.007	7	None	$7.72x10^{-7}$	$2.32x10^{-4}$	$1.10x10^{-4}$	$3.31x10^{-5}$	0	0
Hydrogen sulfide	0.0009	28.4	None	$6.72x10^{-7}$	$2.02x10^{-4}$	$7.47x10^{-4}$	$7.11x10^{-6}$	0	0
Mercury (vapor)	0.0003	0.1	None	$8.58x10^{-8}$	$2.58x10^{-5}$	$2.86x10^{-4}$	$2.58x10^{-4}$	0	0
Methyl alcohol	1.75	260	None	$2.86x10^{-7}$	$8.59x10^{-5}$	$1.63x10^{-7}$	$3.30x10^{-7}$	0	0
Methyl ethyl ketone (MEK)	1	590	None	$1.00x10^{-5}$	$3.01x10^{-3}$	$1.00x10^{-5}$	$5.10x10^{-6}$	0	0
Propylglycol methyl ether	2	368	None	$2.29x10^{-7}$	$6.87x10^{-5}$	$1.14x10^{-7}$	$1.87x10^{-7}$	0	0
Toluene	0.4	766	None	$1.43x10^{-7}$	$4.29x10^{-5}$	$3.57x10^{-7}$	$5.61x10^{-8}$	0	0

TABLE E.3.4–11.—*Risk Assessments from Exposure to Hazardous Chemicals from Downsize Assembly/Disassembly at Pantex Plant*
[Page 2 of 2]

Chemical	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
1,1,1-Trichloroethane (TCA)	0.014	1,900	None	$1.40x10^{-6}$	$4.21x10^{-4}$	$1.00x10^{-4}$	$2.22x10^{-7}$	0	0
Trichloroethylene (TCE)	13.377	546	0.006	$1.43x10^{-7}$	$4.29x10^{-5}$	$1.07x10^{-8}$	$7.87x10^{-7}$	$2.45x10^{-10}$	$9.97x10^{-9}$
Triethylamine	2.45	100	None	$1.43x10^{-8}$	$4.29x10^{-6}$	$5.84x10^{-9}$	$4.29x10^{-8}$	0	0
2,2,4-Trimethyl-1,3-pentane-diol-isobutyrate	-	-	None	$1.43x10^{-8}$	$4.29x10^{-6}$	None	None	0	0
Volatile organic compounds (toluene)	0.4	766	None	$3.57x10^{-4}$	$1.07x10^{-1}$	$8.94x10^{-4}$	$1.40x10^{-4}$	0	0
Xylene	7	434	None	$5.00x10^{-6}$	$1.50x10^{-3}$	$7.15x10^{-7}$	$3.46x10^{-6}$	0	0
Hazard Index[g]						$2.42x10^{-3}$	$1.57x10^{-3}$		
Total Cancer Risk[h]								$8.06x10^{-10}$	$3.28x10^{-8}$

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI - maximally exposed individual of the public.

[c] Hazard Quotient for MEI - boundary annual emissions/reference concentration (RfC).

[d] Hazard Quotient for workers - 100-m, 8-hr emissions/permissible exposure limit (PEL).

[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).

[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).

[g] Hazard index - sum of individual hazard quotients.

[h] Total cancer risk - sum of individual cancer risks.

Source: PX MH 1995a.

TABLE E.3.4–12.—*Risk Assessments from Exposure to Hazardous Chemicals from Phaseout of Assembly/Disassembly and High Explosives Fabrication at Pantex Plant*

	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
None	0	0	None	0	0	0	0	0	0
Hazard Index[g]						0	0		
Total Cancer Risk[h]								0	0

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.
[b] MEI - maximally exposed individual of the public.
[c] Hazard Quotient for MEI - boundary annual emissions/reference concentration (RfC).
[d] Hazard Quotient for workers - 100-m, 8-hr emissions/permissible exposure limit (PEL).
[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).
[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).
[g] Hazard Index - Sum of Individual Hazard Quotients.
[h] Total Cancer Risk - Sum of Individual Cancer Risks.
Source: PX DOE 1995e; PX MH 1995a.

TABLE E.3.4–13.—*Risk Assessments from Exposure to Hazardous Chemicals from No Action at Los Alamos National Laboratory* [Page 1 of 2]

Chemical	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Acetic acid	0.6125	25	None	$5.95x10^{-5}$	$1.3x10^{-2}$	$9.7x10^{-5}$	$5.26x10^{-4}$	0	0
Aluminum (metal and oxide)	0.368	15	None	$4.43x10^{-6}$	$9.79x10^{-4}$	$1.20x10^{-5}$	$6.53x10^{-5}$	0	0
Aluminum welding fumes	0.125	5	None	$1.36x10^{-5}$	$3.01x10^{-3}$	$1.11x10^{-4}$	$6.02x10^{-4}$	0	0
Ammonia	0.1	35	None	$8.85x10^{-5}$	$1.96x10^{-2}$	$8.85x10^{-4}$	$5.59x10^{-4}$	0	0
2-Butoxyethanol	5.88	240	None	$1.36x10^{-5}$	$3.0x10^{-3}$	$2.32x10^{-6}$	$1.25x10^{-5}$	0	0
Carbon monoxide	1.35	55	None	$2.39x10^{-5}$	0.528	$1.77x10^{-3}$	$9.61x10^{-3}$	0	0
Chlorine	0.35	3	None	$1.46x10^{-6}$	$3.23x10^{-4}$	$4.17x10^{-6}$	$1.08x10^{-4}$	0	0
Chloroform	0.035	240	0.081	$1.44x10^{-6}$	$3.18x10^{-4}$	$4.11x10^{-6}$	$1.06x10^{-4}$	$1.37x10^{-6}$	$4.09x10^{-5}$
Cyclohexane	25.725	1050	None	$3.01x10^{-6}$	$6.86x10^{-4}$	$1.21x10^{-7}$	$6.53x10^{-7}$	0	0
Dichlorodifluoromethane (Freon 12)	0.7	4950	None	$1.88x10^{-6}$	$4.16x10^{-4}$	$2.69x10^{-6}$	$8.41x10^{-8}$	0	0
Ethyl acetate	3.15	1400	None	$9.85x10^{-6}$	$2.18x10^{-3}$	$3.13x10^{-6}$	$1.56x10^{-6}$	0	0
Ethyl ether	0.7	1200	None	$1.88x10^{-6}$	$4.16x10^{-4}$	$2.69x10^{-6}$	$3.47x10^{-7}$	0	0
Ethylene glycol	7	127	None	$7.97x10^{-6}$	$1.76x10^{-3}$	$1.14x10^{-6}$	$1.39x10^{-5}$	0	0
Formaldehyde	0.7	0.9375	0.045	$5.43x10^{-6}$	$1.20x10^{-3}$	$7.75x10^{-6}$	$1.28x10^{-3}$	$6.98x10^{-8}$	$2.09x10^{-6}$
Heavy metals	1.06	42.9	None	$1.26x10^{-5}$	$2.79x10^{-3}$	$1.20x10^{-5}$	$6.51x10^{-5}$	0	0
Heptane	49	2000	None	$2.05x10^{-4}$	$4.53x10^{-2}$	$4.18x10^{-6}$	$2.26x10^{-5}$	0	0
Hexane	0.2	1800	None	$8.53x10^{-6}$	$1.89x10^{-3}$	$4.26x10^{-5}$	$1.05x10^{-6}$	0	0
Hexane (other isomers)	0.2	1800	None	$1.33x10^{-6}$	$2.94x10^{-4}$	$6.64x10^{-6}$	$1.63x10^{-7}$	0	0
Hydrocarbons (hexane)	0.2	1800	None	$3.20x10^{-4}$	$7.08x10^{-2}$	$1.60x10^{-3}$	$3.94x10^{-5}$	0	0
Hydrogen chloride	0.007	7	None	$7.06x10^{-5}$	$1.56x10^{-2}$	$1.01x10^{-2}$	$2.23x10^{-3}$	0	0
Hydrogen fluoride	0.21	2.49	None	$2.68x10^{-5}$	$5.93x10^{-3}$	$1.28x10^{-4}$	$2.38x10^{-3}$	0	0
Hydrogen peroxide	0.0343	1.4	None	$2.21x10^{-6}$	$4.90x10^{-4}$	$6.46x10^{-5}$	$3.50x10^{-4}$	0	0
Isobutyl acetate	17.15	700	None	$1.99x10^{-6}$	$4.41x10^{-4}$	$1.16x10^{-7}$	$6.30x10^{-7}$	0	0
Isopropyl alcohol	15	980	None	$5.97x10^{-5}$	$1.32x10^{-2}$	$3.98x10^{-6}$	$1.35x10^{-5}$	0	0
Kerosene	2.45	100	None	$2.88x10^{-5}$	$6.37x10^{-3}$	$1.18x10^{-5}$	$6.37x10^{-5}$	0	0
Lead	0.001225	0.05	None	$2.88x10^{-6}$	$6.37x10^{-4}$	$2.35x10^{-3}$	$1.27x10^{-2}$	0	0
Lead chromate	0.001225	0.05	None	$1.77x10^{-6}$	$3.92x10^{-4}$	$1.45x10^{-3}$	$7.84x10^{-3}$	0	0
Methanol	1.75	260	None	$6.52x10^{-5}$	$1.44x10^{-2}$	$3.73x10^{-5}$	$5.55x10^{-5}$	0	0

TABLE E.3.4–13.—*Risk Assessments from Exposure to Hazardous Chemicals from No Action at Los Alamos National Laboratory* [Page 2 of 2]

	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Methyl chloride	5.145	210	None	$2.88x10^{-6}$	$6.37x10^{-4}$	$5.60x10^{-7}$	$3.03x10^{-6}$	0	0
Methyl ethyl ketone (MEK)	1	590	None	$2.06x10^{-4}$	$4.56x10^{-2}$	$2.06x10^{-4}$	$7.74x10^{-5}$	0	0
Methylene chloride	3	1,765	0.0075	$1.22x10^{-4}$	$2.70x10^{-2}$	$4.07x10^{-5}$	$1.53x10^{-5}$	$2.62x10^{-7}$	$7.85x10^{-6}$
Nickel (metal)	0.0245	1	0.84	$6.09x10^{-6}$	$1.35x10^{-3}$	$2.49x10^{-4}$	$1.35x10^{-3}$	$1.46x10^{-6}$	$4.38x10^{-5}$
Nitric acid	0.1225	5	None	$7.32x10^{-5}$	$1.62x10^{-2}$	$5.97x10^{-4}$	$3.24x10^{-3}$	0	0
Phosgene	0.0098	0.4	None	$2.55x10^{-6}$	$5.63x10^{-4}$	$2.60x10^{-4}$	$1.41x10^{-3}$	0	0
Propylene oxide	0.03	240	0.241	$3.99x10^{-6}$	$8.81x10^{-4}$	$1.33x10^{-4}$	$3.67x10^{-6}$	$2.75x10^{-7}$	$8.22x10^{-6}$
Stoddard solvent	71.05	2,900	None	$2.92x10^{-5}$	$6.46x10^{-3}$	$4.11x10^{-7}$	$2.23x10^{-6}$	0	0
Sulfuric acid	0.0245	1	None	$2.44x10^{-6}$	$5.39x10^{-4}$	$9.94x10^{-5}$	$5.39x10^{-4}$	0	0
Tetrahydrofuran (THF)	14.455	590	None	$1.88x10^{-6}$	$4.16x10^{-4}$	$1.30x10^{-7}$	$7.06x10^{-7}$	0	0
Toluene	0.4	766	None	$2.75x10^{-4}$	$6.08x10^{-2}$	$6.87x10^{-4}$	$7.94x10^{-5}$	0	0
1,1,2-Trichloroethane	0.014	45	0.057	$1.03x10^{-4}$	$2.27x10^{-2}$	$7.33x10^{-3}$	$5.04x10^{-4}$	$1.67x10^{-6}$	$5.01x10^{-5}$
Trichloroethylene (TCE)	13.377	546	0.006	$2.33x10^{-5}$	$5.14x10^{-3}$	$1.74x10^{-6}$	$9.42x10^{-6}$	$3.99x10^{-8}$	$1.19x10^{-6}$
Tungsten	0.1225	5	None	$1.21x10^{-5}$	$2.67x10^{-3}$	$9.85x10^{-5}$	$5.34x10^{-4}$	0	0
VM&P naphtha	8.575	350	None	$6.79x10^{-5}$	$1.50x10^{-2}$	$7.92x10^{-6}$	$4.29x10^{-5}$	0	0
Welding fumes (acetylene)	65.219	2,662	None	$5.66x10^{-5}$	$1.25x10^{-2}$	$8.68x10^{-7}$	$4.70x10^{-6}$	0	0
Xylene	7	435	None	$1.95x10^{-4}$	$4.32x10^{-2}$	$2.79x10^{-5}$	$9.94x10^{-5}$	0	0
Hazard Index[g]						$3.01x10^{-2}$	$4.65x10^{-2}$		
Total Cancer Risk[h]								$5.15x10^{-6}$	$1.54x10^{-5}$

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI - maximally exposed individual of the public.

[c] Hazard Quotient for MEI - boundary annual emissions/reference concentration (RfC).

[d] Hazard Quotient for workers - 100-m, 8-hr emissions/permissible exposure limit (PEL).

[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).

[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).

[g] HI - sum of individual HQ.

[h] Total cancer risk - sum of individual cancer risks.

Source: LANL 1994a

TABLE E.3.4–14.—*Risk Assessments from Exposure to Hazardous Chemicals from Pit Fabrication at Los Alamos National Laboratory*

Chemical	Regulated Exposure Limits/Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Carbon monoxide	1.35	55	None	$3.76x10^{-5}$	$8.33x10^{-3}$	$2.79x10^{-5}$	$1.51x10^{-4}$	0	0
Lead	0.00123	0.05	None	$7.05x10^{-10}$	$1.56x10^{-7}$	$5.75x10^{-7}$	$3.12x10^{-6}$	0	0
Volatile organic compounds (toluene)	0.4	766	None	$7.24x10^{-5}$	$1.60x10^{-2}$	$1.81x10^{-4}$	$2.09x10^{-5}$	0	0
Hazard Index[g]						$2.10x10^{-4}$	$1.75x10^{-4}$	0	0
Total Cancer Risk[h]								0	0

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI - maximally exposed individual of the public.

[c] HQ for MEI - boundary annual emissions/reference concentration (RfC).

[d] HQ for workers - 100-m, 8-hr emissions/permissible exposure limit (PEL).

[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).

[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).

[g] HI - sum of individual HQ.

[h] Total cancer risk - sum of individual cancer risks.

Source: LANL 1995g.

TABLE E.3.4–15.—*Risk Assessments from Exposure to Hazardous Chemicals from Secondary and Case Fabrication at Los Alamos National Laboratory*

	Regulated Exposure Limits/Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Carbon monoxide	1.35	55	None	$1.69x10^{-4}$	$3.75x10^{-2}$	$1.25x10^{-4}$	$6.81x10^{-4}$	0	0
Lead	0.00123	0.05	None	$3.17x10^{-9}$	$7.01x10^{-7}$	$2.59x10^{-6}$	$1.40x10^{-5}$	0	0
Volatile organic compounds (toluene)	0.4	766	None	$3.26x10^{-4}$	$7.21x10^{-2}$	$8.15x10^{-4}$	$9.41x10^{-5}$	0	0
Hazard Index[g]						$9.43x10^{-4}$	$7.89x10^{-4}$		
Total Cancer Risk[h]								0	0

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.
[b] MEI - maximally exposed individual of the public.
[c] HQ for MEI - boundary annual emissions/reference concentration (RfC).
[d] HQ for workers - 100-m, 8-hr emissions/permissible exposure limit (PEL).
[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).
[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).
[g] HI - sum of individual HQ.
[h] Total cancer risk - sum of individual cancer risks.
Source: LANL 1995e.

TABLE E.3.4–16.—*Risk Assessments from Exposure to Hazardous Chemicals from High Explosives Fabrication at Los Alamos National Laboratory*

	Regulated Exposure Limits/Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Acetonitrile	0.021	70	None	$5.03x10^{-7}$	$1.11x10^{-4}$	$2.40x10^{-5}$	$1.59x10^{-6}$	0	0
Ammonia	0.1	35	None	$5.03x10^{-5}$	$1.11x10^{-2}$	$5.03x10^{-4}$	$3.18x10^{-4}$	0	0
Carbon monoxide	1.35	55	None	$5.03x10^{-4}$	$1.11x10^{-1}$	$3.73x10^{-4}$	$2.02x10^{-3}$	0	0
Cyclohexane	25.725	1,050	None	$2.52x10^{-7}$	$5.56x10^{-5}$	$9.78x10^{-9}$	$5.30x10^{-8}$	0	0
Dioxane	8.82	360	None	$2.52x10^{-7}$	$5.56x10^{-5}$	$2.85x10^{-8}$	$1.55x10^{-7}$	0	0
Hydrogen chloride	0.007	7	None	$1.26x10^{-5}$	$2.78x10^{-3}$	$1.80x10^{-3}$	$3.97x10^{-4}$	0	0
Hydrogen fluoride	0.21	2.49	None	$5.03x10^{-6}$	$1.11x10^{-3}$	$2.40x10^{-5}$	$4.47x10^{-4}$	0	0
Methyl ethyl ketone (MEK)	1	590	None	$2.52x10^{-6}$	$5.56x10^{-4}$	$2.52x10^{-6}$	$9.43x10^{-7}$	0	0
Toluene	0.4	766	None	$2.52x10^{-6}$	$5.56x10^{-4}$	$6.29x10^{-6}$	$7.26x10^{-7}$	0	0
Volatile organic compounds (toluene)	0.4	766	None	$5.03x10^{-4}$	$1.11x10^{-1}$	$1.26x10^{-3}$	$1.45x10^{-4}$	0	0
Hazard Index[g]						$3.99x10^{-3}$	$3.33x10^{-3}$		
Total Cancer Risk[h]								0	0

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI - maximally exposed individual of the public.

[c] HQ for MEI - boundary annual emissions/reference concentration (RfC).

[d] HQ for workers - 100-m, 8-hr emissions/permissible exposure limit (PEL).

[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).

[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).

[g] HI - sum of individual HQ.

[h] Total cancer risk - sum of individual cancer risks.

Source: LANL 1995d.

TABLE E.3.4–17.—*Risk Assessments from Exposure to Hazardous Chemicals from Nonnuclear Fabrication at Los Alamos National Laboratory*

	Regulated Exposure Limits/Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[f]
Carbon dioxide	221	9,000	None	5.94×10^{-6}	1.31×10^{-3}	2.69×10^{-8}	1.46×10^{-7}	0	0
Volatile organic compounds (toluene)	0.4	766	None	1.04×10^{-5}	2.30×10^{-3}	2.60×10^{-5}	3.01×10^{-6}	0	0
Hazard Index[g]						2.61×10^{-5}	3.15×10^{-6}		
Total Cancer Risk[h]								0	0

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI - maximally exposed individual of the public.

[c] HQ for MEI - boundary annual emissions/reference concentration (RfC).

[d] HQ for workers - 100-m, 8-hr emissions/permissible exposure limit (PEL).

[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).

[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).

[g] HI - sum of individual HQ.

[h] Total cancer risk - sum of individual cancer risks.

Source: LANL 1995c.

TABLE E.3.4–18.—*Risk Assessments from Exposure to Hazardous Chemicals from Operation of Atlas Facility at Los Alamos National Laboratory*

	Regulated Exposure Limits/Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
None	0	0	None	0	0	0	0	0	0
Hazard Index[g]						0	0		
Total Cancer Risk[h]								0	0

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI - maximally exposed individual of the public.

[c] HQ for MEI - boundary annual emissions/reference concentration (RfC).

[d] HQ for workers - 100-m, 8-hr emissions/permissible exposure limit (PEL).

[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).

[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).

[g] HI - sum of individual HQ.

[h] Total cancer risk - sum of individual cancer risks.

Source: Appendix K.

TABLE E.3.4–19.—*Risk Assessments from Exposure to Hazardous Chemicals from Operation of National Ignition Facility at Los Alamos National Laboratory*

	Regulated Exposure Limits/Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
None	0	0	None	0	0	0	0	0	0
Hazard Index[g]						0	0		
Total Cancer Risk[h]								0	0

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.
[b] MEI - maximally exposed individual of the public.
[c] HQ for MEI - boundary annual emissions/reference concentration (RfC).
[d] HQ for workers - 100-m, 8-hr emissions/permissible exposure limit (PEL).
[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).
[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).
[g] HI - sum of individual HQ.
[h] Total cancer risk - sum of individual cancer risks.
Source: Appendix I.

TABLE E.3.4–20.—*Risk Assessments from Exposure to Hazardous Chemicals from No Action at Lawrence Livermore National Laboratory* [Page 1 of 6]

Chemical	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Acetone	0.35	2,400	None	$1.11x10^{-4}$	$8.16x10^{-3}$	$3.17x10^{-4}$	$3.40x10^{-6}$	0	0
Aliphatic hydrocarbon (cyclohexane)	25.725	1,050	None	$1.05x10^{-6}$	$7.73x10^{-5}$	$4.08x10^{-8}$	$7.36x10^{-8}$	0	0
Aluminum (fume and dust)	0.368	15	None	$1.02x10^{-5}$	$7.52x10^{-4}$	$2.78x10^{-5}$	$5.01x10^{-5}$	0	0
Ammonia	0.1	35	None	$3.91x10^{-6}$	$2.88x10^{-4}$	$3.91x10^{-5}$	$8.23x10^{-6}$	0	0
Ammonium hydroxide	0.0499	2	None	$3.49x10^{-6}$	$2.57x10^{-4}$	$7.00x10^{-5}$	$1.28x10^{-4}$	0	0
Amyl acetate	12.8625	525	None	$9.38x10^{-10}$	$6.90x10^{-8}$	$7.29x10^{-11}$	$1.31x10^{-10}$	0	0
Aromatic 150 (light aromatic naptha)	-	-	None	$3.36x10^{-6}$	$2.45x10^{-4}$	None	None	0	0
Aromatic hydrocarbons (pyrene)	0.105	4.57	None	$1.60x10^{-4}$	$1.18x10^{-2}$	$1.53x10^{-3}$	$2.58x10^{-3}$	0	0
Arsenic (inorganic compounds)	0.00105	0.01	50	$5.73x10^{-10}$	$4.22x10^{-8}$	$5.46x10^{-7}$	$4.22x10^{-6}$	$8.20x10^{-9}$	$8.16x10^{-8}$
Benzene	0.0796	3.25	0.029	$1.70x10^{-5}$	$1.25x10^{-3}$	$2.14x10^{-4}$	$3.85x10^{-4}$	$1.41x10^{-7}$	$1.41x10^{-6}$
Berylium	0.0175	0.002	None	$3.36x10^{-10}$	$2.47x10^{-8}$	$1.92x10^{-8}$	$1.24x10^{-5}$	0	0
Bromine	0.01715	0.7	None	$2.52x10^{-15}$	$1.85x10^{-13}$	$1.47x10^{-13}$	$2.65x10^{-13}$	0	0
2-Butoxyethanol	5.88	240	None	$2.92x10^{-5}$	$2.14x10^{-3}$	$4.96x10^{-6}$	$8.94x10^{-6}$	0	0
t-Butyl alcohol	7.35	300	None	$6.97x10^{-7}$	$5.13x10^{-5}$	$9.49x10^{-8}$	$1.71x10^{-7}$	0	0
1-Butanol	0.35	300	None	$8.60x10^{-7}$	$6.33x10^{-5}$	$2.46x10^{-6}$	$2.11x10^{-7}$	0	0
Cadmium	0.00175	0.005	$1.8x10^{-6}$	$1.43x10^{-9}$	$1.05x10^{-7}$	$8.19x10^{-7}$	$2.11x10^{-5}$	$7.38x10^{-16}$	$7.34x10^{-15}$
Carbon monoxide	1.35	55	None	$6.78x10^{-4}$	$4.99x10^{-2}$	$5.02x10^{-4}$	$9.06x10^{-4}$	0	0
Carbon tetrachloride	0.00245	63.9	0.013	$3.44x10^{-5}$	$2.53x10^{-3}$	$1.40x10^{-2}$	$3.96x10^{-5}$	$1.28x10^{-7}$	$1.27x10^{-6}$
Carbon tetrafluoride	-	-	None	$1.76x10^{-12}$	$1.29x10^{-10}$	None	None	0	0
CFC-113	105	7,600	None	$4.03x10^{-8}$	$2.96x10^{-6}$	$3.83x10^{-10}$	$3.90x10^{-10}$	0	0
CFC-13 (chlorotrifluoromethane)	-	-	None	$1.03x10^{-3}$	$7.59x10^{-7}$	None	None	0	0
Chlorine	.35	3	None	$6.44x10^{-7}$	$4.74x10^{-5}$	$1.84x10^{-6}$	$1.58x10^{-5}$	0	0
Chlorobenzene	0.07	350	None	$6.34x10^{-8}$	$4.66x10^{-6}$	$9.06x10^{-7}$	$1.33x10^{-8}$	0	0

TABLE E.3.4–20.—*Risk Assessments from Exposure to Hazardous Chemicals from No Action at Lawrence Livermore National Laboratory* [Page 2 of 6]

Chemical	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Chloroform	0.035	240	0.0061	$3.13x10^{-5}$	$2.30x10^{-3}$	$8.94x10^{-4}$	$9.59x10^{-6}$	$5.46x10^{-8}$	$5.44x10^{-7}$
Chromium (hexavalent)	0.0175	1	41	$2.97x10^{-11}$	$2.18x10^{-9}$	$1.69x10^{-9}$	$2.18x10^{-9}$	$3.48x10^{-10}$	$3.46x10^{-9}$
Copper (particulates)	0.0245	1	None	$3.36x10^{-7}$	$2.47x10^{-5}$	$1.37x10^{-5}$	$2.47x10^{-6}$	0	0
Cyclohexane	25.725	1,050	None	$1.96x10^{-5}$	$1.44x10^{-3}$	$7.61x10^{-7}$	$1.37x10^{-6}$	0	0
Cyclohexanone	17.5	200	None	$1.53x10^{-5}$	$1.13x10^{-3}$	$8.74x10^{-7}$	$5.63x10^{-6}$	0	0
Diacetone alcohol	5.88	240	None	$1.20x10^{-6}$	$8.81x10^{-5}$	$2.04x10^{-7}$	$3.67x10^{-7}$	0	0
Dibutyl phthalate	0.35	5	None	$2.93x10^{-6}$	$2.16x10^{-5}$	$8.38x10^{-6}$	$4.32x10^{-5}$	0	0
1,1-Dichloroethane	9.8	400	None	$2.56x10^{-11}$	$1.89x10^{-9}$	$2.62x10^{-12}$	$4.72x10^{-12}$	0	0
1,1-Dichloroethylene (vinylidene chloride)	0.0315	20	0.6	$7.07x10^{-10}$	$5.20x10^{-8}$	$2.24x10^{-8}$	$2.60x10^{-9}$	$1.21x10^{-10}$	$1.21x10^{-9}$
1,2-Dichloroethylene	0.07	790	None	$5.29x10^{-11}$	$3.89x10^{-9}$	$7.55x10^{-10}$	$4.92x10^{-12}$	0	0
Diethyleneglycol monobutyl ether	-	-	None	$8.41x10^{-7}$	$6.19x10^{-5}$	None	None	0	0
Diglycol monomethyl ether	-	-	None	$1.17x10^{-8}$	$8.59x10^{-7}$	None	None	0	0
1,4-Dioxane	8.82	360	0.011	$1.51x10^{-7}$	$1.11x10^{-5}$	$1.71x10^{-8}$	$3.08x10^{-8}$	$4.75x10^{-10}$	$4.73x10^{-9}$
Dipropyleneglycol methyl ether	14.84	600	None	$1.45x10^{-6}$	$1.07x10^{-4}$	$9.79x10^{-8}$	$1.78x10^{-7}$	0	0
Epichlorohydrin	0.001	19	0.0099	$1.17x10^{-8}$	$8.59x10^{-7}$	$1.17x10^{-5}$	$4.52x10^{-8}$	$3.31x10^{-11}$	$3.29x10^{-10}$
Epoxy resins (toluene-2,4-diisocyanate)	0.00343	0.14	None	$4.81x10^{-7}$	$3.54x10^{-5}$	$1.40x10^{-4}$	$2.53x10^{-4}$	0	0
Ethanol	46.55	1,900	None	$5.47x10^{-5}$	$4.03x10^{-3}$	$1.18x10^{-6}$	$2.12x10^{-6}$	0	0
1-Methoxy-2-propanal acetate	-	-	None	$2.71x10^{-7}$	$1.99x10^{-5}$	None	None	0	0
Ethanolamine	0.147	6	None	$5.23x10^{-6}$	$3.85x10^{-4}$	$2.56x10^{-5}$	$6.41x10^{-5}$	0	0
2-Ethoxyethyl acetate	13.23	540	None	$3.77x10^{-8}$	$2.78x10^{-6}$	$2.85x10^{-9}$	$5.14x10^{-9}$	0	0
Ethyl acrylate	2.45	100	None	$1.65x10^{-12}$	$1.81x10^{-10}$	$6.72x10^{-13}$	$1.21x10^{-12}$	0	0
Ethyl benzene	1	435	None	$4.40x10^{-7}$	$3.23x10^{-5}$	$4.40x10^{-7}$	$7.43x10^{-8}$	0	0
Ethylene dichloride	10.069	411	None	$5.06x10^{-10}$	$3.73x10^{-8}$	$5.03x10^{-11}$	$9.06x10^{-11}$	0	0
Ethylene glycol	?	246	None	$1.89x10^{-6}$	$1.39x10^{-4}$	$2.62x10^{-7}$	$1.85x10^{-7}$	0	0

TABLE E.3.4–20.—*Risk Assessments from Exposure to Hazardous Chemicals from No Action at Lawrence Livermore National Laboratory* [Page 3 of 6]

Chemical	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Ethylene glycol monoethyl ether	18.13	740	None	5.60×10^{-7}	4.12×10^{-5}	3.09×10^{-8}	5.56×10^{-8}	0	0
Ethylene glycol monomethyl ether	0.02	80	None	5.60×10^{-7}	4.12×10^{-5}	2.80×10^{-5}	5.15×10^{-7}	0	0
Ethyltriacetoxysilane	-	-	None	8.71×10^{-9}	6.41×10^{-7}	None	None	0	0
Ferric chloride (iron, salts)	0.0245	1	None	4.20×10^{-12}	3.09×10^{-10}	1.71×10^{-10}	3.09×10^{-10}	0	0
Fiberglass particles (fibrous glass dust)	0.1225	5	None	7.63×10^{-14}	5.61×10^{-12}	6.23×10^{-13}	1.12×10^{-12}	0	0
Fluoride	0.061	2.5	None	1.91×10^{-7}	1.40×10^{-5}	3.13×10^{-6}	5.61×10^{-6}	0	0
Folpet	0.35	14.3	0.0035	2.81×10^{-8}	2.07×10^{-6}	8.02×10^{-8}	1.44×10^{-7}	2.81×10^{-11}	2.80×10^{-10}
Formaldehyde	0.7	0.9375	None	9.65×10^{-6}	7.10×10^{-4}	1.38×10^{-5}	7.57×10^{-4}	0	0
Freon 113	105	7,600	None	2.05×10^{-4}	1.84×10^{-2}	2.38×10^{-6}	2.42×10^{-6}	0	0
Freon 14 (gas) (carbon tetrafluoride)	-	-	None	5.76×10^{-6}	4.24×10^{-4}	None	None	0	0
Glass, fibrous or dust (fibrous glass dust)	0.1225	5	None	1.98×10^{-7}	1.46×10^{-5}	1.62×10^{-6}	2.92×10^{-6}	0	0
Gasoline	21.805	890	None	2.77×10^{-4}	2.03×10^{-2}	1.27×10^{-5}	2.29×10^{-5}	0	0
Hexane	0.2	1,800	None	1.12×10^{-5}	8.25×10^{-4}	5.61×10^{-5}	4.58×10^{-7}	0	0
Hydrochloric acid	0.007	7	None	5.60×10^{-7}	4.12×10^{-5}	8.00×10^{-5}	5.88×10^{-6}	0	0
Hydrogen bromide	0.245	10	None	2.67×10^{-7}	1.96×10^{-5}	1.09×10^{-6}	1.96×10^{-6}	0	0
Hydrogen chloride	0.007	7	None	1.18×10^{-5}	8.67×10^{-4}	1.68×10^{-3}	1.24×10^{-4}	0	0
Hydrogen cyanide	0.07	11	None	2.69×10^{-7}	1.98×10^{-5}	3.84×10^{-6}	1.80×10^{-6}	0	0
Hydrogen fluoride	0.21	2.49	None	1.61×10^{-6}	1.19×10^{-4}	7.67×10^{-6}	4.76×10^{-5}	0	0
Hydrogen sulfide	0.0009	28.4	None	4.88×10^{-7}	3.59×10^{-5}	5.43×10^{-4}	1.27×10^{-6}	0	0
Hydrotreated heavy naptha	9.8	400	None	6.21×10^{-6}	4.57×10^{-4}	6.34×10^{-7}	1.14×10^{-6}	0	0
Isoamyl acetate	12.8625	525	None	9.38×10^{-10}	6.90×10^{-8}	7.29×10^{-11}	1.31×10^{-10}	0	0
Isobutanol	1.05	300	None	2.71×10^{-8}	1.99×10^{-6}	2.58×10^{-8}	6.64×10^{-9}	0	0
Isobutyl isobutyrate	1.79	73.1	None	4.81×10^{-5}	3.53×10^{-3}	2.68×10^{-5}	4.84×10^{-5}	0	0

TABLE E.3.4–20.—*Risk Assessments from Exposure to Hazardous Chemicals from No Action at Lawrence Livermore National Laboratory* [Page 4 of 6]

Chemical	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Isopropropyl acetate	23.275	950	None	7.02×10^{-6}	5.17×10^{-4}	3.02×10^{-7}	5.44×10^{-7}	0	0
Isopropropyl alcohol	24.01	980	None	9.39×10^{-5}	6.90×10^{-3}	3.91×10^{-6}	7.05×10^{-6}	0	0
Kerosene	2.45×10^{-5}	0.001	None	3.22×10^{-5}	2.37×10^{-3}	1.32	2.37	0	0
Lacquer thinner (no solvent indicated)	-	-	None	5.34×10^{-12}	3.93×10^{-10}	None	None	0	0
Lead	0.001225	0.05	None	2.66×10^{-8}	1.96×10^{-6}	2.17×10^{-5}	3.91×10^{-5}	0	0
Lithium	-	-	None	7.63×10^{-9}	5.61×10^{-7}	None	None	0	0
Manganese (compounds)	0.00005	5	None	1.91×10^{-10}	1.40×10^{-8}	3.82×10^{-6}	2.81×10^{-9}	0	0
Mercury (vapor)	0.0003	0.1	None	4.05×10^{-10}	2.98×10^{-8}	1.35×10^{-6}	2.98×10^{-7}	0	0
Methane	-	-	None	8.24×10^{-8}	6.06×10^{-6}	None	None	0	0
Methanol	1.75	260	None	1.14×10^{-4}	8.39×10^{-3}	6.51×10^{-5}	3.23×10^{-5}	0	0
Methyl chloroform (TCA)	0.1225	1,900	None	4.10×10^{-5}	3.02×10^{-3}	3.35×10^{-4}	1.59×10^{-6}	0	0
Methyl ethyl ketone (MEK)	1	590	None	4.02×10^{-5}	2.96×10^{-3}	4.02×10^{-5}	5.01×10^{-6}	0	0
Methylene chloride	3	1,765	0.0075	3.74×10^{-5}	2.75×10^{-3}	1.25×10^{-5}	1.56×10^{-6}	8.03×10^{-8}	7.99×10^{-7}
Methylene diphenyl diisocyanate	-	-	None	5.6×10^{-7}	4.12×10^{-5}	None	None	0	0
Methyl cyclohexane	49	2,000	None	1.96×10^{-5}	1.44×10^{-3}	3.99×10^{-7}	7.20×10^{-7}	0	0
Methyl isobutyl ketone (MIBK)	0.28	410	None	2.43×10^{-5}	1.79×10^{-3}	8.68×10^{-5}	4.36×10^{-6}	0	0
Methyl-n-amyl ketone	11.3925	465	None	2.41×10^{-5}	1.78×10^{-3}	2.12×10^{-6}	3.82×10^{-6}	0	0
Methyltriacetoxysilane	-	-	None	5.81×10^{-9}	4.27×10^{-7}	None	None	0	0
Mineral spirits (stoddard solvent)	71.05	2,900	None	1.59×10^{-8}	1.17×10^{-7}	2.23×10^{-10}	4.03×10^{-10}	0	0
N-butyl acetate	17.4	710	None	6.26×10^{-5}	4.61×10^{-3}	3.60×10^{-6}	6.49×10^{-6}	0	0
N-heptane	49	2,000	None	2.01×10^{-5}	1.48×10^{-3}	4.11×10^{-7}	7.40×10^{-7}	0	0
N-propyl alcohol	12.25	500	None	1.02×10^{-7}	7.52×10^{-6}	8.35×10^{-9}	1.50×10^{-8}	0	0
Naptha (coal tar)	9.8	400	None	1.59×10^{-7}	1.17×10^{-5}	1.63×10^{-8}	2.93×10^{-8}	0	0

TABLE E.3.4–20.—*Risk Assessments from Exposure to Hazardous Chemicals from No Action at Lawrence Livermore National Laboratory* [Page 5 of 6]

Chemical	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Napthalene	1.225	50	None	$5.34x10^{-12}$	$3.93x10^{-10}$	$4.36x10^{-12}$	$7.86x10^{-12}$	0	0
Napthene	1.225	50	None	$1.60x10^{-4}$	$1.18x10^{-2}$	$1.31x10^{-4}$	$2.36x10^{-4}$	0	0
Napthol spirits	-	-	None	$1.29x10^{-5}$	$9.48x10^{-4}$	None	None	0	0
Nickel	0.0245	1	0.84	$2.32x10^{-8}$	$1.71x10^{-6}$	$9.48x10^{-7}$	$1.71x10^{-6}$	$5.58x10^{-9}$	$5.56x10^{-8}$
Nitric acid	0.1225	5	None	$2.65x10^{-7}$	$1.95x10^{-5}$	$2.16x10^{-6}$	$3.90x10^{-6}$	0	0
Nitrocellulose	-	-	None	$9.38x10^{-10}$	$6.90x10^{-8}$	None	None	0	0
Organics (toluene)	0.4	766	None	$2.91x10^{-5}$	$2.14x10^{-3}$	$7.27x10^{-5}$	$2.79x10^{-6}$	0	0
Pentane	72.275	2,950	None	$7.94x10^{-9}$	$.5.84x10^{-7}$	$1.10x10^{-10}$	$1.98x10^{-10}$	0	0
Perchloric acid	-	-	None	$4.14x10^{-7}$	$3.05x10^{-5}$	None	None	0	0
Perchloroethylene (tetrachloroethylene)	0.035	689	None	$6.95x10^{-7}$	$5.11x10^{-5}$	$1.99x10^{-5}$	$7.42x10^{-8}$	0	0
Perfluorochemical (Freon 113)	105	7,600	None	$1.17x10^{-4}$	$8.59x10^{-3}$	$1.11x10^{-6}$	$1.13x10^{-6}$	0	0
Petroleum distillates (vm&p naptha)	49	2,000	None	$3.80x10^{-7}$	$2.80x10^{-5}$	$7.76x10^{-9}$	$1.40x10^{-8}$	0	0
Petroleum naptha	49	2,000	None	$1.69x10^{-5}$	$1.24x10^{-3}$	$3.45x10^{-7}$	$6.22x10^{-7}$	0	0
Phosphoric acid	0.0245	1	None	$2.56x10^{-7}$	$1.89x10^{-5}$	$1.05x10^{-5}$	$1.89x10^{-5}$	0	0
Polycyclic aromatic hydrocarbons (pyr)	0.105	4.57	None	$3.10x10^{-9}$	$2.23x10^{-7}$	$2.96x10^{-8}$	$5.00x10^{-8}$	0	0
Polyethylene glycol	640.5	1.83	None	$8.60x10^{-9}$	$6.33x10^{-7}$	$1.34x10^{-11}$	$3.46x10^{-9}$	0	0
Polyvinyl acetate			None	$1.03x10^{-8}$	$7.56x10^{-7}$	None	None	0	0
Potassium ferricyanide	0.07	5	None	$5.60x10^{-7}$	$4.12x10^{-5}$	$8.00x10^{-6}$	$8.23x10^{-6}$	0	0
Potassium fluoborate	-	-	None	$5.6x10^{-7}$	$4.12x10^{-5}$	None	None	0	0
Potassium fluozirconate	-	-	None	$5.6x10^{-7}$	$4.12x10^{-5}$	None	None	0	0
Propylene glycol	-	-	None	$1.75x10^{-7}$	$1.29x10^{-5}$	None	None	0	0
Radionuclide (Uranium-235 and -338)	0.0105	0.25	None	$5.73x10^{-5}$	$4.21x10^{-3}$	$5.45x10^{-3}$	$1.68x10^{-2}$	0	0
Silane (silicon tetrahydride)	0.1715	7	None	$6.87x10^{-8}$	$5.05x10^{-6}$	$4.00x10^{-7}$	$7.22x10^{-7}$	0	0

TABLE E.3.4–20.—*Risk Assessments from Exposure to Hazardous Chemicals from No Action at Lawrence Livermore National Laboratory* [Page 6 of 6]

Chemical	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Silicon tetrafluoride	-	-	None	1.60×10^{-12}	1.18×10^{-10}	None	None	0	0
Stoddard solvent	71.05	2,900	None	7.97×10^{-6}	5.86×10^{-4}	1.12×10^{-7}	2.02×10^{-7}	0	0
Styrene (monomer)	1	433	None	2.14×10^{-4}	1.57×10^{-2}	2.14×10^{-4}	3.63×10^{-5}	0	0
Sulfur hexafluoride	147	6,000	None	5.72×10^{-8}	4.21×10^{-6}	3.89×10^{-10}	7.02×10^{-10}	0	0
Sulfuric acid	0.0245	1	None	3.95×10^{-6}	2.91×10^{-4}	1.61×10^{-4}	2.91×10^{-4}	0	0
Tetraethylene pentamine	-	-	None	1.55×10^{-8}	1.14×10^{-6}	None	None	0	0
Tetrahydrofuran (THF)	14.455	590	None	8.05×10^{-7}	5.92×10^{-5}	5.57×10^{-8}	1.00×10^{-7}	0	0
Toluene	0.4	766	None	5.28×10^{-5}	3.89×10^{-3}	1.32×10^{-4}	5.07×10^{-6}	0	0
Toluene diisocyanate	0.00343	0.14	None	3.68×10^{-7}	2.71×10^{-5}	1.07×10^{-4}	1.93×10^{-4}	0	0
Trichloroethylene (TCE)	13.377	546	0.006	2.11×10^{-5}	1.55×10^{-3}	1.57×10^{-6}	2.84×10^{-6}	3.61×10^{-8}	3.60×10^{-7}
Tricresyl phosphate	0.728	29.7	None	3.97×10^{-8}	2.92×10^{-6}	5.54×10^{-8}	9.83×10^{-8}	0	0
Tripropyleneglycol methyl ether	4.62	18.9	None	5.60×10^{-7}	4.12×10^{-5}	1.21×10^{-7}	2.18×10^{-7}	0	0
Volatile Organic Compounds (toluene)	0.4	766	None	7.52×10^{-5}	5.53×10^{-3}	1.88×10^{-4}	7.22×10^{-6}	0	0
Xylene	7	435	None	2.95×10^{-5}	2.17×10^{-3}	4.22×10^{-6}	5.00×10^{-6}	0	0
Zinc	0.01	0.408	None	2.52×10^{-15}	1.85×10^{-13}	2.52×10^{-13}	4.54×10^{-13}	0	0
Hazard Index[g]						1.34	2.39×10^{-1}	0	0
Total Cancer Risk[h]								4.55×10^{-7}	4.53×10^{-6}

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.
[b] MEI - maximally exposed individual of the public.
[c] Hazard Quotient for MEI - boundary annual emissions/reference concentration (RfC).
[d] Hazard Quotient for workers - 100-m, 8-hr emissions/permissible exposure limit (PEL).
[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).
[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).
[g] Hazard Index - sum of individual Hazard Quotients.
[h] Total cancer risk - sum of individual cancer risks.
Source: LLNL 1995i:1.

TABLE E.3.4–21.—*Risk Assessments from Exposure to Hazardous Chemicals from Secondary and Case Fabrication at Lawrence Livermore National Laboratory*

Chemical	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Carbon dioxide	221	9,000	None	$5.34x10^{-1}$	$3.93x10^{+1}$	$2.42x10^{-3}$	$4.37x10^{-3}$	0	0
Carbon monoxide	1.35	55	None	$1.53x10^{-4}$	$1.12x10^{-2}$	$1.13x10^{-4}$	$2.04x10^{-4}$	0	0
Hydrogen fluoride	0.21	2.49	None	$5.34x10^{-5}$	$3.93x10^{-3}$	$2.54x10^{-4}$	$1.58x10^{-3}$	0	0
Hydrogen sulfide	0.0009	28.4	None	$5.57x10^{-6}$	$4.10x10^{-4}$	$6.19x10^{-3}$	$1.44x10^{-5}$	0	0
Hazard Index[g]						$8.97x10^{-3}$	$6.16x10^{-3}$	0	0
Total Cancer Risk[h]								0	0

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.
[b] MEI - maximally exposed individual of the public.
[c] Hazard Quotient for MEI - boundary annual emissions/reference concentration (RfC).
[d] Hazard Quotient for workers - 100-meter, 8-hr emissions/permissible exposure limit (PEL).
[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).
[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).
[g] Hazard Index - sum of individual Hazard Quotients.
[h] Total cancer risk - sum of individual cancer risks.
Source: LLNL 1995e.

TABLE E.3.4–22.—*Risk Assessments from Exposure to Hazardous Chemicals from High Explosives Fabrication at Lawrence Livermore National Laboratory* [Page 1 of 2]

Chemical	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Acetonitrile	0.021	70	None	$2.29x10^{-6}$	$1.68x10^{-4}$	$1.09x10^{-4}$	$2.41x10^{-6}$	0	0
Ammonia	0.1	35	None	$5.34x10^{-7}$	$3.93x10^{-5}$	$5.34x10^{-6}$	$1.12x10^{-6}$	0	0
Benzene	0.0796	3.25	0.029	$3.82x10^{-8}$	$2.81x10^{-6}$	$4.79x10^{-7}$	$8.64x10^{-7}$	$3.16x10^{-10}$	$3.15x10^{-9}$
Bisphenol-alpha-epichlorohydrin (epichloro)	0.001	19	0.0042	$7.63x10^{-8}$	$5.61x10^{-6}$	$7.63x10^{-5}$	$2.95x10^{-7}$	$9.17x10^{-11}$	$9.13x10^{-10}$
Carbon monoxide	1.35	55	None	$1.91x10^{-5}$	$1.40x10^{-3}$	$1.41x10^{-5}$	$2.55x10^{-5}$	0	0

TABLE E.3.4–22.—*Risk Assessments from Exposure to Hazardous Chemicals from High Explosives Fabrication at Lawrence Livermore National Laboratory* [Page 2 of 2]

	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Chloroform	0.0035	240	0.0061	$7.63x10^{-8}$	$5.61x10^{-6}$	$2.18x10^{-6}$	$2.34x10^{-8}$	$1.33x10^{-10}$	$1.33x10^{-9}$
Cyclohexane	25.725	1050	None	$7.63x10^{-8}$	$5.61x10^{-6}$	$2.97x10^{-9}$	$5.35x10^{-9}$	0	0
Dibutyl phthalate	0.35	5	None	$7.63x10^{-9}$	$5.61x10^{-7}$	$2.18x10^{-8}$	$1.12x10^{-7}$	0	0
1,1-Dichloroethane	9.8	400	None	$1.53x10^{-7}$	$1.12x10^{-5}$	$1.56x10^{-8}$	$2.81x10^{-8}$	0	0
Dimethyl formamide	0.03	30	None	$7.63x10^{-8}$	$5.61x10^{-6}$	$2.54x10^{-6}$	$1.87x10^{-7}$	0	0
1,4-Dioxane	8.82	360	0.011	$7.63x10^{-8}$	$5.61x10^{-6}$	$8.65x10^{-9}$	$1.56x10^{-8}$	$2.40x10^{-10}$	$2.39x10^{-9}$
Hexane	0.2	1800	None	$7.63x10^{-8}$	$5.61x10^{-6}$	$3.82x10^{-7}$	$3.12x10^{-9}$	0	0
Hydrogen chloride	0.007	7	None	$7.63x10^{-6}$	$5.61x10^{-4}$	$1.09x10^{-3}$	$8.02x10^{-5}$	0	0
Hydrogen fluoride	0.21	2.49	None	$1.53x10^{-5}$	$1.12x10^{-3}$	$7.27x10^{-5}$	$4.51x10^{-4}$	0	0
Hydrogen sulfide	0.0009	28.4	None	$3.82x10^{-8}$	$2.81x10^{-6}$	$4.24x10^{-5}$	$9.88x10^{-8}$	0	0
Methanol	1.75	260	None	$7.63x10^{-8}$	$5.61x10^{-6}$	$4.36x10^{-8}$	$2.16x10^{-8}$	0	0
Methyl ethyl ketone (MEK)	1	590	None	$3.82x10^{-8}$	$2.81x10^{-6}$	$3.82x10^{-8}$	$4.76x10^{-9}$	0	0
N-Butyl glycidyl ether	6.615	270	None	$1.14x10^{-6}$	$8.42x10^{-5}$	$1.73x10^{-7}$	$3.12x10^{-7}$	0	0
Propyl glycol methyl ether	2	360	None	$3.82x10^{-8}$	$2.81x10^{-6}$	$1.91x10^{-8}$	$7.80x10^{-9}$	0	0
Toluene	0.4	766	None	$7.63x10^{-8}$	$5.61x10^{-6}$	$1.91x10^{-7}$	$7.33x10^{-9}$	0	0
Trichloroethylene (TCE)	13.377	546	0.006	$3.82x10^{-8}$	$2.81x10^{-6}$	$5.85x10^{-9}$	$5.14x10^{-9}$	$6.55x10^{-11}$	$6.52x10^{-10}$
Triethylamine	0.007	100	None	$3.82x10^{-8}$	$2.81x10^{-6}$	$5.45x10^{-6}$	$2.81x10^{-8}$	0	0
Xylene	7	435	None	$4.58x10^{-7}$	$3.37x10^{-5}$	$6.54x10^{-8}$	$7.74x10^{-8}$	0	0
Hazard Index[g]						$1.42x10^{-3}$	$5.62x10^{-4}$		
Total Cancer Risk[h]								$8.47x10^{-10}$	$8.43x10^{-9}$

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI - maximally exposed individual of the public.

[c] Hazard Quotient for MEI - boundary annual emissions/reference concentration (RfC).

[d] Hazard Quotient for workers - 100-meter, 8-hr emissions/permissible exposure limit (PEL).

[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).

[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).

[g] Hazard Index - sum of individual Hazard Quotients.

[h] Total cancer risk - sum of individual cancer risks.

Source: Ashby 1995a

TABLE E.3.4–23.—*Risk Assessments from Exposure to Hazardous Chemicals from Nonnuclear Fabrication at Lawrence Livermore National Laboratory*

Chemical	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Acetone	0.35	2,400	None	$1.53x10^{-5}$	$1.12x10^{-3}$	$4.36x10^{-5}$	$4.68x10^{-7}$	0	0
Isopropyl alcohol	24.01	980	None	$3.05x10^{-5}$	$2.25x10^{-3}$	$1.27x10^{-6}$	$2.29x10^{-6}$	0	0
Methyl ethyl ketone (MEK)	1	590	None	$1.30x10^{-6}$	$9.54x10^{-5}$	$1.30x10^{-6}$	$1.62x10^{-8}$	0	0
Toluene	0.4	766	None	$1.30x10^{-6}$	$9.54x10^{-5}$	$3.24x10^{-6}$	$1.25x10^{-8}$	0	0
Hazard Index[g]						$4.94x10^{-5}$	$3.05x10^{-6}$		
Total Cancer Risk[h]								0	0

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI - maximally exposed individual of the public.

[c] Hazard Quotient for MEI - boundary annual emissions/reference concentration (RfC).

[d] Hazard Quotient for workers - 100-meter, 8-hr emissions/permissible exposure limit (PEL).

[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).

[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).

[g] Hazard Index - sum of individual Hazard Quotients.

[h] Total cancer risk - sum of individual cancer risks.

Source: LLNL 1995f.

TABLE E.3.4–24.—*Risk Assessments from Exposure to Hazardous Chemicals from Operation of Contained Firing Facility at Lawrence Livermore National Laboratory*

	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
None	0	0	None	0	0	0	0	0	0
Hazard Index[g]						0	0		
Total Cancer Risk[h]								0	0

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.
[b] MEI - maximally exposed individual of the public.
[c] Hazard Quotients for MEI - boundary annual emissions/reference concentration (RfC).
[d] Hazard Quotients for workers - 100-meter, 8-hr emissions/permissible exposure limit (PEL).
[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).
[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).
[g] Hazard Index - sum of individual Hazard Quotients.
[h] Total cancer risk - sum of individual cancer risks.
Source: Appendix J.

TABLE E.3.4–25.—*Risk Assessments from Exposure to Hazardous Chemicals from Operation of National Ignition Facility at Lawrence Livermore National Laboratory*

	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
None	0	0	None	0	0	0	0	0	0
Hazard Index[g]						0	0		
Total Cancer Risk[h]								0	0

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.
[b] MEI - maximally exposed individual of the public.
[c] Hazard Quotients for MEI - boundary annual emissions/reference concentration (RfC).
[d] Hazard Quotients for workers - 100-meter, 8-hr emissions/permissible exposure limit (PEL).
[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).
[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).
[g] Hazard Index - sum of individual Hazard Quotients.
[h] Total cancer risk - sum of individual cancer risks.

TABLE E.3.4–26.—*Risk Assessments from Exposure to Hazardous Chemicals from No Action at Sandia National Laboratories*

Chemical	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Chlorofluorocarbons	105	7600	None	$5.49x10^{-6}$	$2.70x10^{-3}$	$5.23x10^{-8}$	$3.55x10^{-7}$	0	0
Gasoline (vapors)	21.805	890	None	$3.11x10^{-6}$	$1.53x10^{-3}$	$1.43x10^{-7}$	$1.72x10^{-6}$	0	0
1,1,1-Trichloroethane (TCA)	0.014	1900	0.057	$3.23x10^{-5}$	$1.59x10^{-2}$	$2.31x10^{-3}$	$8.35x10^{-6}$	0	0
Hazard Index[g]						$2.31x10^{-3}$	$1.04x10^{-5}$		
Total Cancer Risk[h]								$5.27x10^{-7}$	$3.5x10^{-5}$

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI - maximally exposed individual of the public.

[c] Hazard Quotients for MEI - boundary annual emissions/reference concentration (RfC).

[d] Hazard Quotients for workers - 100-meter, 8-hr emissions/permissible exposure limit (PEL).

[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).

[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).

[g] Hazard Index - sum of individual Hazard Quotients.

[h] Total cancer risk - sum of individual cancer risks.

Source: LLNL 1995i:1.

TABLE E.3.4–27.—*Risk Assessments from Exposure to Hazardous Chemicals from Nonnuclear Fabrication at Sandia National Laboratories*

	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Acetone	0.35	2,400	None	$1.16x10^{-5}$	$5.68x10^{-3}$	$3.30x10^{-5}$	$2.36x10^{-6}$	0	0
Isopropyl alcohol	24.01	980	None	$1.05x10^{-4}$	$5.17x10^{-2}$	$4.38x10^{-6}$	$5.27x10^{-5}$	0	0
Methyl ethyl ketone (MEK)	1	590	None	$7.14x10^{-6}$	$3.51x10^{-3}$	$7.14x10^{-6}$	$5.94x10^{-6}$	0	0
Toluene	0.4	766	None	$2.00x10^{-5}$	$9.83x10^{-3}$	$5.01x10^{-5}$	$1.28x10^{-5}$	0	0
Trichloroethylene (TCE)	13.377	546	0.006	$9.63x10^{-5}$	$4.73x10^{-2}$	$7.20x10^{-6}$	$8.66x10^{-5}$	$1.65x10^{-7}$	$1.10x10^{-5}$
Hazard Index[g]						$1.02x10^{-4}$	$1.60x10^{-4}$		
Total Cancer Risk[h]								$1.65x10^{-7}$	$1.10x10^{-5}$

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.
[b] MEI - maximally exposed individual of the public.
[c] Hazard Quotients for MEI - boundary annual emissions/reference concentration (RfC).
[d] Hazard Quotients for workers - 100-meter, 8-hr emissions/permissible exposure limit (PEL).
[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).
[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).
[g] Hazard Index - sum of individual Hazard Quotients.
[h] Total cancer risk - sum of individual cancer risks.
Source: KC ASI 1995a; SNL 1995e.

TABLE E.3.4–28.—*Risk Assessments from Exposure to Hazardous Chemicals from Operation of National Ignition Facility at Sandia National Laboratories*

	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
None	0	0	None	0	0	0	0	0	0
Hazard Index[g]						0	0		
Total Cancer Risk[h]								0	0

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.
[b] MEI - maximally exposed individual of the public.
[c] Hazard Quotients for MEI - boundary annual emissions/reference concentration (RfC).
[d] Hazard Quotients for workers - 100-meter, 8-hr emissions/permissible exposure limit (PEL).
[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).
[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).
[g] Hazard Index - sum of individual Hazard Quotients.
[h] Total cancer risk - sum of individual cancer risks.
Source: Appendix I.

TABLE E.3.4–29.—*Risk Assessments from Exposure to Hazardous Chemicals from No Action at Nevada Test Site*

	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
None	0	0	None	0	0	0	0	0	0
Hazard Index[g]						0	0		
Total Cancer Risk[h]								0	0

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.
[b] MEI - maximally exposed individual of the public.
[c] Hazard Quotients for MEI - boundary annual emissions/reference concentration (RfC).
[d] Hazard Quotients for workers - 100-meter, 8-hr emissions/permissible exposure limit (PEL).
[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).
[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).
[g] Hazard Index - sum of individual Hazard Quotients.
[h] Total cancer risk - sum of individual cancer risks.
Source: NT DOE 1996c.

TABLE E.3.4–30.—*Risk Assessments from Exposure to Hazardous Chemicals from Assembly/Disassembly at Nevada Test Site*

	Regulated Exposure Limits/ Risk Factors			Emissions Inventory		Hazard Quotient		Cancer Risk	
Chemical	RfC (mg/m^3)	PEL[a] (mg/m^3)	Slope Factor (mg/kg/day)	Boundary Annual MEI[b] (mg/m^3)	Worker 100 m 8 hours (mg/m^3)	Boundary Annual MEI[b,c]	Worker 100 m 8 hours[d]	Boundary Annual MEI[b,e]	Worker 100 m 8 hours[f]
Acetonitrile	0.021	70	None	3.82×10^{-11}	4.41×10^{-7}	1.82×10^{-9}	6.30×10^{-9}	0	0
Benzene	0.0796	3.25	0.029	1.15×10^{-10}	1.32×10^{-6}	1.44×10^{-9}	4.07×10^{-7}	7.50×10^{-13}	1.48×10^{-9}
Carbon monoxide	1.35	55	None	5.73×10^{-8}	6.61×10^{-4}	4.24×10^{-8}	1.20×10^{-5}	0	0
Cresylic acid	0.539	22	None	3.82×10^{-11}	4.41×10^{-7}	7.09×10^{-11}	2.00×10^{-8}	0	0
1,2-Dichloroethane (ethylene dichloride)	10.069	411	0.091	3.82×10^{-11}	4.41×10^{-7}	3.79×10^{-12}	1.07×10^{-9}	9.94×10^{-13}	1.55×10^{-9}
Dimethylformamide (DMF)	0.03	30	None	1.15×10^{-10}	1.32×10^{-6}	3.82×10^{-9}	4.41×10^{-8}	0	0
Hydrogen chloride	0.007	7	None	3.82×10^{-10}	4.41×10^{-6}	5.46×10^{-8}	6.30×10^{-7}	0	0
Hydrogen sulfide	0.0009	28.4	None	3.82×10^{-10}	4.41×10^{-6}	4.24×10^{-7}	1.55×10^{-7}	0	0
Mercury (vapor)	0.0003	0.1	None	3.82×10^{-11}	4.41×10^{-7}	1.27×10^{-7}	4.41×10^{-6}	0	0
Methyl alcohol	1.75	260	None	1.91×10^{-10}	2.20×10^{-6}	1.09×10^{-13}	8.48×10^{-9}	0	0
Methyl ethyl ketone (MEK)	1	590	None	6.49×10^{-9}	7.50×10^{-5}	6.49×10^{-9}	1.27×10^{-7}	0	0
Propylglycol methyl ether			None	1.15×10^{-10}	1.32×10^{-6}	5.73×10^{-11}	3.67×10^{-9}	0	0
Ozone	0.0049	0.2	None	3.06×10^{-7}	3.53×10^{-3}	6.24×10^{-5}	1.76×10^{-2}		
Toluene	0.4	766	None	3.06×10^{-9}	3.53×10^{-5}	7.64×10^{-9}	4.61×10^{-8}	0	0
1,1,1-Trichloroethane (TCA)	0.1225	1,900	None	7.64×10^{-10}	8.82×10^{-6}	6.24×10^{-9}	4.64×10^{-9}	0	0
Trichloroethylene (TCE)	13.377	546	0.006	1.15×10^{-10}	1.32×10^{-6}	8.57×10^{-12}	2.42×10^{-9}	1.97×10^{-13}	3.07×10^{-10}
Xylene	7	434	None	3.06×10^{-9}	3.53×10^{-5}	4.37×10^{-10}	8.13×10^{-8}	0	0
Hazard Index[g]						6.03×10^{-5}	1.77×10^{-2}	2.14×10^{-12}	3.35×10^{-9}
Total Cancer Risk[h]								1.70×10^{-12}	5.03×10^{-9}

[a] See the Chemical Health Effects Technical Reference (TTI 1996b) for the ACGIH-TLV, NIOSH-REL, and other exposure limit values.

[b] MEI - maximally exposed individual of the public.

[c] Hazard Quotients for MEI - boundary annual emissions/reference concentration (RfC).

[d] Hazard Quotients for workers - 100-meter, 8-hr emissions/permissible exposure limit (PEL).

[e] Cancer risk for MEI - (emissions concentrations) x (0.286 [converts concentration to dose]) x (slope factor [SF]).

[f] Cancer risk for workers - (emissions for 8-hr) x (0.237 [fraction of year exposed]) x (0.571 [fraction of lifetime working]) x (0.286 [converts concentration to dose]) x (slope factor).

[g] Hazard Index - sum of individual Hazard Quotients.

[h] Total cancer risk - sum of individual cancer risks.

Source: NTS DOE (1997).

E.4 HEALTH EFFECTS STUDIES: EPIDEMIOLOGY

Various epidemiologic studies have been conducted at some of the sites evaluated in this PEIS because of the concern for potential adverse health effects associated with the manufacture and testing of nuclear weapons. These studies focus on the DOE workforce and residents of communities surrounding DOE sites.

E.4.1 Background

The health effects associated with ionizing radiation exposure were first published about 60 years ago. Studies published in the 1930s first documented cancer among painters who used radium to paint watch dials back in 1910 to 1920. Radiation therapy for disease has been used since the 1930s and studies have shown that the risk of cancer was related to the amounts of radiation received. Nuclear weapons research and manufacture, and consequent exposure to radiation occurred beginning in the late 1930s. Exposure to radionuclides has changed over time with higher levels occurring in the early days of research and production. Numerous epidemiologic studies have been conducted among workers who manufactured and tested nuclear weapons due to the concern with potential adverse health effects. More recently, concerns about radiologic contaminants offsite have resulted in health studies among communities that surround DOE facilities. The following section briefly gives an overview of epidemiology followed by a review of epidemiologic studies of sites evaluated in this PEIS.

Epidemiology is the study of the distribution and determinants of disease in human populations. The distribution of disease is considered in relation to time, place, and person. Relevant population characteristics should include the age, race, and sex distribution of a population, as well as other characteristics related to health, such as social characteristics (e.g., income and education), occupation, susceptibility to disease, and exposure to specific agents. Determinants of disease include the causes of disease, as well as factors that influence the risk of disease.

E.4.1.1 *Study Designs*

Ecologic Studies. Ecologic studies compare the frequency of a disease in groups of people in conjunction with simple descriptive studies of geographical information in an attempt to determine how health events among populations vary with levels of exposure. These groups may be identified as the residents of a neighborhood, a city, or a county where demographic information and disease or mortality data are available. Exposure to specific agents may be defined in terms of residential location or proximity to a particular area, such as distance from a waste disposal site. An example of an ecologic study is a comparison of the rate of heart disease among community residents by drinking water quality.

The major disadvantage of ecologic studies is that the measure of exposure is based on the average level of exposure in the community, when what is really of interest is each individual's exposure. Ecologic studies do not take into account other factors such as age and race that may also be related to disease. These types of studies may lead to incorrect conclusions, an "ecologic fallacy." For the above example, it would be incorrect to assume that the level of water hardness influences the risk of getting heart disease. Despite the obvious problems with ecologic studies, they can be a useful first step in identifying possible associations between the risk of disease and environmental exposures. However, because of their potential for bias they should never be considered more than an initial step in investigation of disease causation.

Cohort Studies. The cohort study design is a type of epidemiologic study frequently used to examine occupational exposures within a defined workforce. A cohort study requires a defined population that can be classified as being exposed or not exposed to an agent of interest, such as radiation or chemicals that influence the probability of occurrence of a given disease. Characterization of the exposure may be qualitative (e.g., high, low, or no exposure) or very quantitative (e.g., radiation measured in Sieverts (Sv), chemicals in parts per million [ppm]). Surrogates for exposure, such as job titles, are frequently used in the absence of quantitative exposure data.

Individuals enumerated in the study population are tracked for a period of time and fatalities recorded. In general, overall rates of death and cause-specific rates of death have been assessed for workers at the PEIS sites. Death rates for the exposed worker pop-

ulation are compared with death rates of workers who did not have the exposure (internal comparison), or compared with expected death rates based on the U.S. population or state death rates (external comparison). If the rates of death differ from what is expected, an association is said to exist between the disease and exposure. In cohorts where the exposure has not been characterized, excess mortality can be identified, but these deaths cannot be attributed to a specific exposure, and additional studies may be warranted. More recent studies have looked at other disease endpoints, such as overall and cause-specific cancer incidence (newly diagnosed) rates.

Most cohort studies at PEIS sites have been historical cohort studies, that is, the exposure occurred some time in the distant past. These studies rely on past records to document exposure. This type of study can be problematic if exposure records are incomplete or were destroyed. Cohort studies require extremely large populations that have been followed for many (20 to 30) years. They are generally difficult to conduct and are very expensive. These studies are not well suited to studying diseases that are rare. Cohort studies do, however, provide a direct estimate of the risk of death from a specific disease, and allow an investigator to look at many disease end points.

Case-Control Studies. The case-control study design starts with the identification of persons with the disease of interest (case) and a suitable comparison (control) population of persons without the disease. Controls must be persons who are at risk for the disease and are representative of the population that generated the cases. The selection of an appropriate control group is often quite problematic. Cases and controls are then compared with respect to the proportion of individuals exposed to the agent of interest. Case-control studies require fewer persons than cohort studies, and therefore, are usually less costly and less time consuming, but are limited to the study of one disease (or cause of death). These types of studies are well suited for the study of rare diseases and are generally used to examine the relationship between a specific disease and exposure.

E.4.1.2 *Definitions*

Unfamiliar terms frequently used in epidemiologic studies, including those used in this document, are defined below.

Age, gender, and cigarette smoking are the principal determinants of mortality. Standardization is a statistical method used as a control for the effects of age, gender, or other characteristics so that death rates may be compared among different population groups. There are two ways to standardize rates, the indirect or direct methods. In general, the indirect method of standardization is most frequently used.

Indirect Standardization: The disease rates in the reference (comparison) population are multiplied by the number of individuals in the same age and gender groups in the study population to obtain the expected rate of disease for the study population.

Direct Standardization: The disease rates in the study population are multiplied by the number of individuals in the same age and gender group in the reference (comparison) population. This gives the expected rates of disease for the reference population if these rates had prevailed in that group.

Standardized Mortality Ratio: The standardized mortality rate (SMR) is the ratio of the number of deaths observed in the study population to the number of expected deaths. The expected number of deaths is based on a reference (or comparison population). Death rates for the U.S. (or state) population are most frequently used as the comparison to obtain expected rates. An SMR of 1 indicates a similar risk of disease in the study population compared with the reference population. An SMR greater than 1 indicates excess risk of disease in the study population compared with the reference group, and an SMR less than 1 indicates a deficit of disease.

Relative Risk: The ratio of the risk of disease among the exposed population to the risk of disease in the nonexposed population. Relative risks are estimated from cohort studies.

Odds Ratio: The ratio of the odds of disease if exposed, to the odds of disease if not exposed. Under certain conditions the odds ratio approximates the relative risk. Odds ratios are estimated from case-control studies.

E.4.2 Oak Ridge Reservation

Surrounding Communities. The population-based National Cancer Institute's mortality survey for

selected nuclear facilities *Cancer in Populations Living Near Nuclear Facilities* (NIH Publication No. 90-874, July 1990) examined the cancer mortality within an 80 km (50 mi) radius around several nuclear facilities, including Anderson and Roane counties (JAMA 1991a:1403-1408). No excess cancer mortality was observed in the population living in the exposed counties when compared to the U.S. white male population, nor when compared to the population of the control counties (Blount, Bradley, Coffee, Jefferson, and Hamblen, TN, and Henderson, NC), nor when time trends were assessed.

Tennessee Medical Management, Inc. used data from the Tennessee Cancer Reporting System to compare mortality and incidence data for counties near Oak Ridge, Tennessee, for the 3-year period, 1988 to 1990, to the U.S. population (TMM 1993a). For Oak Ridge, total deaths from all causes was significantly lower than expected. For Anderson County, the observed number of deaths from uterine cancer and from cancer of respiratory and intrathoracic organs was statistically greater than expected and the number of deaths from brain cancer, breast cancer, and the "all other sites" category were lower than expected for Anderson County. For Roane County, the number of deaths from cancer of the respiratory and intrathoracic organs was statistically greater than expected. The number of deaths from cancer of the digestive organs and the peritoneum; from uterine cancer; and from lip, oral cavity, and pharynx cancer was lower than expected.

Tennessee Medical Management, Inc. examined new (incident) cancer cases and identified the following as statistically significant: For Anderson County, the observed numbers of cases of cancer of the prostate and of cancer of the lung and bronchus were greater than expected. Leukemia, stomach and small intestine cancers, and cancers of the colon and intestinal tract were lower than expected. For Roane County, the number of cases of cancer of the lung and bronchus was greater than expected. Non-Hodgkin's lymphoma, female breast cancer, esophageal cancer, cancer of the pancreas, and cancer in all sites were lower than expected. The only consistent excess reported for both cancer mortality and cancer incidence was for cancer of respiratory and intrathoracic organs.

Because of a concern for possible contamination of the population by mercury, the Tennessee Department of Health and Environment conducted a pilot study in 1984 (TN DHE 1984a). The study showed no difference in urine or hair mercury exposures (residence or activity in contaminated areas based on soil measurements or consumption of fish caught in the contaminated areas), compared to those with little potential exposure. Mercury levels in some soils measured as high as 2,000 ppm. Analysis of a few soil samples showed that most of the mercury in the soil, however, was inorganic, thereby lowering the probability of bioaccumulation and health effects. Examination of the long-term effects of exposure to mercury and other chemicals continues.

State Health Agreement Program. Under the State Health Agreement Program managed by DOE's Office of Epidemiologic Studies, a grant was awarded to the Tennessee Department of Health and Environment. The purpose of the grant was to determine the extent of exposure to contaminants among workers and residents of the surrounding community as a result of ORR operations, and to assess the current status of health outcomes and determine their potential association with these exposures.

A dose reconstruction feasibility study began in 1992, with the contract awarded by the State of Tennessee to ChemRisk. The contractor performed extensive review of Oak Ridge documents and issued a report, which concluded that sufficient information exists to reconstruct past releases and offsite doses caused by radioactive and hazardous materials. The report also concluded that doses from mercury, polychlorinated biphenyl, radioactive iodine, and radioactive cesium may have been great enough to cause harmful health effects in the offsite population. Based on this information, a full dose reconstruction study was initiated in August 1994.

Other activities supported under the grant include: development of a birth defects registry, a quality improvement program for the Tennessee cancer registry, a review and evaluation of the DOE occupational medical program, and the implementation of a community participation/public information program.

Technical support to the State health department is provided by a 12-member Oak Ridge Health Agreement Steering Panel. The Health Advisory Panel provides direction and oversight to those working on health studies, ensures public input, and informs the public of activities related to the health studies. A representative of the Centers for Disease Control and Prevention's National Center for Environmental Health is a member of the advisory panel. A representative from DOE serves as an ex-officio member.

Workers. Between 1943 and 1985, there were 118,588 male and female individuals of all races who were employed in any of the Oak Ridge facilities. These included Oak Ridge National Laboratory (ORNL) for nuclear research (also called the X-10 Facility); the Y-12 Plant (Y-12) under management of the Tennessee-Eastman Corporation (1943 to 1947), which produced enriched uranium by the electromagnetic separation process; Y-12 under management of Union Carbide (1948 to 1984), which fabricated and certified nuclear weapons parts; and the K-25 Site (K-25) (Oak Ridge Gaseous Diffusion Plant), which produced enriched uranium through the gaseous process. Analyses at the Oak Ridge facilities have been carried out mostly for white males, and for specific cohorts taking into consideration time-related exposure risks.

Oak Ridge National Laboratory. The mortality experience of 8,375 white males employed at least a month between 1943 and 1972 at ORNL was compared with the U.S. white male population using SMR analyses in a 1985 paper by Checkoway et al. (BJIM 1985a:525-533). Increases in deaths from leukemia (SMR - 1.49, 16 observed), cancer of the prostate (SMR - 1.16, 14 observed), and Hodgkin's disease (SMR - 1.10, 5 observed) were observed, although none were statistically significant. Dose response analyses were performed for all causes of death combined, all cancers combined, leukemia, and prostate cancer comparing exposed worker death rates with nonexposed worker death rates. Dosimetry data were available for the entire period of the study with the total population external radiation dose measuring 13,500 mrem. No dose response gradients were observed. Death rates were calculated for 11 different job categories by length of time in each job in an attempt to determine whether specific work environments were related to cancer and leukemia. Leukemia mortality was observed to be related to length of employment in engineering and maintenance jobs.

Followup to this cohort study was expanded through 1984 in an updated study by Wing et al. (JAMA 1991a:1397-1402). Again, death rates in the worker population were compared with those in the U.S. population. Nonstatistically significant increases were noted for cancers of the pancreas (SMR - 1.09, 25 observed), prostate (SMR - 1.05, 26 observed), brain (SMR - 1.04, 15 observed), and lymphosarcoma and/or reticulasarcoma (SMR - 1.05, 9 observed). There was a significant increase in deaths from leukemia (SMR - 1.63, 28 observed, 95 percent confidence interval [CI] 1.08-2.35). The total population external radiation dose was 144 Sv. Dose response analyses performed for all causes except cancer, lung cancer, and leukemia did not demonstrate a relationship between level of external radiation and increased risk of death from these outcomes. There was a significant dose response relationship (4.94 percent per 1,000 mrem) between cancer deaths and level of external radiation dose using models with a 20-year lag. A subgroup of workers who were monitored for internal contamination had nonstatistically elevated SMRs for cancer of the prostate (SMR - 1.12, 10 observed) and lymphosarcoma and/or reticulasarcoma (SMR - 1.65, 6 observed). The workers monitored for internal contamination had a statistically significant elevated SMR for leukemia (SMR - 2.23 16 observed, 95 percent CI 1.27-3.62).

A second publication on the above data set examined the effect of controlling for a number of possible selection and confounding factors on the risk coefficient for all cancer dose responses (AJIM 1993a:265-279). Models were adjusted for the following variables with little change in the previously reported risk coefficient: employment during the World War II era, short-term employment, job category, and exposure to beryllium, lead, and mercury. The authors concluded that the previously calculated dose response estimate was fairly stable when adjustments were made for a wide range of potential confounders that were not explored in the earlier study.

Y-12 Plant. Y–12 is a nuclear weapons materials fabrication plant where the radiologic exposure of

greatest concern is internal exposure from the inhalation of uranium compounds. The Tennessee Eastman Corporation managed the plant from 1943 to 1947. Polednak and Frome reported a followup through 1974 of all 18,869 white male workers employed at Y-12 from 1943 to 1947 (JOM 1981a:169-178). The workers included those exposed to internal (alpha) and external (beta) radiation through the inhalation of uranium dusts, electrical workers who performed maintenance in the exposed areas, and other nonexposed workers. Individual measures of exposure were not available for any members of this cohort, so exposure levels were inferred from plant areas of work and jobs. High average air levels of uranium dust were documented in departments employing chemical workers. Elevated SMRs were observed for mental, psychoneurotic, personality disorders (SMR - 1.36, 36 observed), emphysema (SMR - 1.16, 100 observed), diseases of the bones and organs of movement (SMR - 1.22, 11 observed), lung cancer (SMR - 1.09, 324 observed), and external causes of death (SMR - 1.09, 623 observed). The lung cancer SMR was greater among workers employed for 1 year or more compared with workers employed less than 1 year and was more pronounced in workers hired at the age of 45 or older (SMR - 1.51; 95 percent CI 1.01-2.31). Of the workers employed after the age of 44, the SMR for lung cancer was greatest for electrical workers (SMR - 1.55, 7 observed), alpha chemistry workers (SMR - 3.02, 7 observed), and beta process workers (SMR - 1.51, 11 observed).

During the early operation of Y-12 from 1942 to 1947, a group of male workers was exposed to phosgene gas on a chronic basis (N - 694) and a smaller group of males received acute exposures (N - 106) along with a small group of females (N - 91) (ER 1980a:357-367; TIH 1985a:137-147). A control group of 9,280 workers who also worked at Y-12 during the same era, but who did not have phosgene exposure, was also described. All groups were followed through the end of 1978. The SMRs for the chronically exposed group and the control group were similar for all causes examined. There was no evidence for increased mortality from respiratory diseases in this group and the SMR for lung cancer, while elevated, was similar to the lung cancer SMR for workers in the rest of the plant. Among those with acute exposures, the SMR for respiratory diseases was elevated (SMR - 2.66, 5 observed) and this elevation may be related to residual lung damage from the acute phosgene exposure. It was difficult to trace the vital status of the 91 women; therefore, description of these highly exposed workers was limited to listing the frequency of their initial symptoms after exposure. As expected, nausea, vomiting, and coughing were the most frequently reported symptoms. Unexpectedly, the women experienced a lower frequency of pneumonitis than their male counterparts.

The portion of the Y-12 cohort employed between 1947 and 1974 was described in a study by Checkoway et al. (AJE 1988a:255-266). This study included 6,781 white male workers first employed at Y-12 between 1947 and 1974 who were employed for at least 30 days. Mortality data were collected for the cohort through the end of 1979 and were used to perform SMR and cause specific dose-response analyses. Nonstatistically significant increases were observed for all cancers (SMR - 1.01, 196 observed), diseases of the blood-forming organs (SMR - 1.48, 3 observed), kidney cancer (SMR - 1.22, 6 observed), brain cancer (SMR - 1.80, 14 observed), and other lymphatic cancers (SMR - 1.86, 9 observed). A statistically significant increase in deaths from lung cancer (SMR - 1.36, 89 observed; 95 percent CI - 1.09-1.67) was observed compared with the U.S. lung cancer rates, but not with Tennessee lung cancer rates (SMR - 1.18, 95 percent CI - 0.95-1.45). Dose-response analyses for lung cancer and internal alpha radiation dose and external gamma radiation dose did not reveal a positive relationship for a 0- or 10-year lag. Examination of lung cancer rates distributed across both internal and external dose categories suggested a dose-response with external radiation dose among individuals who had 5 or more rems of internal dose. Brain cancer was not related to the level of internal or external radiation dose.

The Y-12 cohort studied by Checkoway was updated through the end of 1990 by Loomis and Wolf and included African-American and white female workers (AJIM 1996a:131-141). The dose-response analyses were not included in the update; therefore, only SMR analyses are reported. For all workers examined as a group, nonstatistically significant elevations were observed for cancer of the pancreas (SMR - 1.36, 34 observed), skin cancer (SMR - 1.07, 11 observed), breast cancer (females only, SMR - 1.21, 11 observed), prostate cancer

(SMR - 1.31, 36 observed), kidney cancer (SMR - 1.30, 16 observed), brain cancer (SMR - 1.29, 20 observed), cancers of other lymphatic tissues (SMR - 1.32, 22 observed), and diseases of the blood-forming organs (SMR - 1.23, 6 observed). The SMR for lung cancer was statistically significant (SMR - 1.17, 202 observed; 95 percent CI 1.01-1.34), particularly in the white male segment of the population (SMR - 1.20, 194 observed; 95 percent CI - 1.04-1.38). Examination of the lung cancer mortality by year of hire, latency, duration of employment, and calendar year at risk indicated the excess was confined to those who were first hired before 1954 (SMR - 1.27, 161 observed), and was greatest in persons employed 5 to 20 years with 10 to 30 years of followup. Elevated lung cancer deaths was first evident between 1955 and 1964 and continued to increase from 1975 to 1979, followed by a decrease in lung cancer death rates.

Between 1953 and 1963 Y-12 used mercury in a process to produce large quantities of enriched lithium. Cragle et al. studied all workers employed at Y-12 at least 5 months between January 1, 1953 and April 30, 1958 (N - 5,663) (JOM 1984a:817-821). This group was categorized into workers exposed to mercury and workers not exposed to mercury based *on results of urinalysis* data supplied by the plant. Vital status followup was complete through the end of 1978 and SMRs were calculated. Compared with nonexposed workers, there were no differences in the mortality patterns for: 1) mercury-exposed workers as a whole, 2) workers with the highest mercury exposures, and 3) workers employed more than a year in a mercury process. The authors acknowledge that mortality is not the optimal end point to assess health effects related to mercury exposure.

The mercury workers were involved in a clinical study by Albers et al. who examined 502 Y-12 workers, 247 of whom worked in the mercury process 20 to 35 years prior to the examination (AN 1988a:651-659). Correlations between declining neurological function and increasing exposure were identified. An exposure assessment was determined for each mercury worker during the time of employment in the mercury process. Study subjects who had at least one urinalysis equal to or greater than 0.6 mg/liters of mercury showed decreased strength, coordination, and sensation along with increased tremor, and prevalence of Babinski and snout reflexes when compared with the 255 nonexposed workers. Clinical polyneuropathy was associated with the level of the highest exposure, but not with the duration of exposure.

K-25 Site. K-25 enriched uranium beginning in 1945 using a gaseous diffusion process. There was potential exposure to uranium dust, oxidized uranium compounds, uranium hexafluoride, and a number of chemical compounds used in the process. In later years of operation, the gas centrifuge process was used to enrich uranium. No analyses of death rates for this population have been published; however, health effects have been studied.

Powdered nickel was used at K-25 in the production of the barrier material used to separate and enrich uranium. Workers who fabricated the barrier material were exposed to nickel powder through inhalation. Cragle et al. (IARC 1984a:57-63) updated an earlier study by Godbold et al. (JOM 1979a:799-806) of 814 workers who were employed in the manufacture of barrier material between 1948 and 1953. A comparison group of white males employed at K-25 sometime between 1948 and 1953 (N - 7,552) was also selected. The SMRs in the barrier group were similar to those in the nonbarrier worker group for most noncancer outcomes. The nickel workers were noted to have a higher rate of death from cancers of the buccal cavity and pharynx (SMR - 2.92, 3 observed) than the nonnickel workers (SMR - 0.23, 3 observed). When the directly standardized rates were compared, the rate of buccal cavity and pharynx cancer in the nickel workers was approximately 19 times higher than the rate in the nonnickel workers. The authors acknowledge that the number of cases is quite small and recommended additional followup to determine if this trend continued. There were no nasal sinus cancers observed in the worker population exposed to metallic nickel, in contrast to the results of studies of workers in nickel refineries where the rates of sinus cancer related to nickel compounds are quite high.

K-25 workers employed in the gas centrifuge process were the focus of an interview study by Cragle et al. (AOEH 1992a:826-834). The study was conducted in order to determine the incidence rate for cancer and illness symptoms among workers exposed to epoxy resin and solvents prevalent in the process. A total of 263 workers determined to have worked

closest and longest to the process were compared with 271 employees employed at the plant during the same time, but did not work in the centrifuge process. The centrifuge workers and the noncentrifuge workers had similar overall cancer incidence rates. However, the centrifuge workers reported five incident bladder cancers versus none reported by the noncentrifuge group. The centrifuge workers also reported significantly more rashes, dizziness, and numb or tingling limbs during employment, which are symptoms associated with high solvent exposure. One of the epoxy resins used in the early years of the process was a potential bladder carcinogen, but none of the workers with bladder cancer had jobs that required routine, hands-on work with that material. A specific causative agent for the increase in bladder cancer was not identified.

Combined Oak Ridge Reservation Facilities. Frome et al. reported on the mortality experience of World War II workers employed at three ORR facilities between 1943 and 1947 (RR 1990a:138-152). Poisson regression analyses were used as a control for potential confounders such as facility of employment, socioeconomic status, period of follow-up, and birth year. The cohort included white males employed at any ORR facility at least 30 days between the start of the operation and 1947 and were never employed at an ORR facility after 1947 (N - 28,008). Elevated mortality was statistically significant for all causes (SMR - 1.11, 11,671 observed); tuberculosis (SMR - 1.37, 108 observed); mental, psychoneurotic, and personality disorders (SMR - 1.60, 81 observed); cerebrovascular disease (SMR - 1.11, 833 observed); diseases of the respiratory system (SMR - 1.25, 792 observed); emphysema (SMR - 1.24, 209 observed); all accidents (SMR - 1.28, 694 observed); and motor vehicle accidents (SMR - 1.44, 339 observed). The only elevated site-specific cancer that was statistically significant was lung cancer (SMR - 1.27, 850 observed). A surrogate for radiation exposure based on a worker's job and department was used to indicate the probability of exposure. This surrogate for actual radiation exposure was not associated with increased rates of cancer.

Carpenter investigated earlier reports of an association between brain cancer and employment at Y-12 by conducting a case-control study of workers employed between 1943 and 1977 at ORNL or Y-12 (JOM 1987a:601-604). Cases consisted of 72 white males and 17 white females with brain cancer. Four controls were selected for each case matched on age, sex, cohort, year of birth, and year of hire. Analyses with respect to internal and external radiation exposures indicated no association with brain cancer. Two companion papers were also published from this case-control study, one examined relationships between brain cancer and chemical exposures (AJIM 1988a:351-362) and the other examined non-occupational risk factors (AJPH 1987a:1180-1182). No statistically significant association between the use of 26 chemicals evaluated and the risk of brain cancer was observed. The chemicals evaluated included those encountered in welding fumes, beryllium, mercury, 4,4-methylene bis 2-chloroaniline or MOCA, cutting oils, thorium, methylene chloride, and other solvents. Excess brain cancer was observed, however, among individuals employed for more than 20 years (odds ratio - 7.0, 9 cases; 95 percent CI 1.2-41.1). Analysis of 82 cases with complete medical records revealed an association with a previous diagnosis of epilepsy (odds ratio - 5.7, 4 cases; 95 percent CI 1.0-32.1) recorded for pre-employment and health status followup.

Causes of death among white male welders (N - 1,059) employed between 1943 and 1973 at Y-12, K-25, and ORNL were studied by Polednak (AEH 1981a:235-242). Based on deaths reported through 1974, mortality from all causes for welders was slightly lower than that expected based on death rates for U.S. white males (SMR - 0.87, 173 observed). Nonstatistically significant decreases in mortality were also observed for all cancers (SMR - 0.88, 32 observed), especially digestive cancer (SMR - 0.49, 5 observed); diseases of the circulatory system (SMR - 0.74, 72 observed); diseases of the digestive system (SMR - 0.76, 9 observed); and accidents (SMR - 0.89, 16 observed). Nonstatistically significant increases were noted for lung cancer (SMR - 1.50, 17 observed); diseases of the respiratory system (SMR - 1.33, 13 observed), especially emphysema (SMR - 2.21, 6 observed); and suicide (SMR - 1.64, 10 observed). A sub-group of welders (N - 536) exposed to nickel oxides (possible respiratory carcinogens) at K-25 were compared with welders at the other two facilities (N - 523). The risk of lung cancer and other respiratory diseases did not differ between the two groups.

Combined Nuclear Sites. ORR workers have been included in several studies that have examined occupational risks across the nuclear complex, both in the United States and internationally. These combined studies have been undertaken in an attempt to increase the statistical power of the studies to detect the effects of low-level chronic radiation exposure.

Y-12 workers were included in a lung cancer case-control study of workers from the Fernald Feed Materials and Production Center cohort and the Mallinckrodt Chemical Works cohort. Dupree et al. conducted a nested case-control study of lung cancer (N - 787) to investigate the relationship between lung cancer and uranium dust exposure (Epidemiology 1995a:370-375). Eligible cases included workers who were employed at least 183 days in any of the facilities and died before January 1, 1983, with lung cancer listed anywhere on the death certificate. Inclusion of deaths through 1982 allowed over 30 years of observation at each facility. One control was matched to each case on facility, race, gender, and birth and hire dates within 3 years. Data collected on all study members included smoking history, first pay code (a surrogate for socioeconomic status), complete work histories, and occupational radiation monitoring records. Annual radiation lung dose from deposited uranium was estimated for each study member. Annual external whole body doses from gamma radiation were determined for workers who had personal monitoring data available. Potential confounders considered in the analysis were smoking (ever/never used tobacco) and pay code (monthly/nonmonthly). With a 10-year lag, cumulative lung doses ranged from 1 to 137 rads for cases and from 0 to 80 rads for controls. The odds ratios for lung cancer mortality for seven cumulative internal dose groups did not demonstrate increasing risk with increasing dose. An odds ratio of 2.0 was estimated for those exposed to 25 rads or more, but the 95 percent confidence interval of -.20 to 20 showed great uncertainty in the estimate. There was a suggestion of an exposure effect for workers hired at age 45 years or older.

A combined site mortality study included workers from ORNL, the Hanford Site, and the Rocky Flats Plant (RR 1993a:408-421). Earlier analyses of these cohorts indicated that risk estimates calculated through extrapolation from high-dose data to low-dose data did not seriously underestimate risks of exposure to low-dose radiati (AJE 1990a:917-927; RR 1989a:19-35). T updated analyses were performed in order determine whether the extrapolated risks represent an over-estimation of the true risk at low doses. T study population consisted of white males employ at one of the three facilities for at least 6 months a monitored for external radiation. The Hanford pop lation also included females and nonwhite worker The total population dose was 123,700 rem Analyses included trend tests for site-specific cance deaths and several broad noncancer categories. Sta tistically significant trends were noted for cancer o the esophagus, cancer of the larynx, and Hodgkin's disease. These cancers were not related to radiatio exposure levels in previously published studies. Excess relative risk models were calculated for the combined DOE populations and for each DOE site separately. Without exception, all risk estimates included the possibility of zero risk (i.e., the confidence interval for the risk coefficient went from below zero to above zero). There was evidence of an increase in the excess relative risk for cancer with increasing age in the Hanford and ORNL populations; both populations showed significant correlations of all cancer with radiation dose among those 75 years and older.

An international effort to pool data from populations exposed to external radiation included the ORNL population in addition to other radiation worker populations in the United States, Canada, and Britain (RR 1995a:117-132). The cohort comprised 95,673 workers (85.4 percent men) employed 6 months or longer and the population dose was 384,320 rem. There was no evidence of an association between radiation dose and mortality from all causes or from all cancers. There was a significant dose-response relationship with leukemia, excluding chronic lymphocytic leukemia (excess relative risk - 2.18 per 100 rem; 90 percent CI 0.1-5.7) and multiple myeloma (excess relative risk not computed; 44 observed). The study results do not suggest that current radiation risk estimates for cancer at low levels of exposure are appreciably in error.

Memorandum of Understanding. DOE entered into a Memorandum of Understanding with the Department of Health and Human Services to conduct health studies at DOE sites. The National Institute for Occupational Safety and Health is

responsible for the conduct or management of worker studies.

The following studies are managed by the National Institute for Occupational Safety and Health with funding from DOE: a study of multiple myeloma among workers at K-25 at ORR (expected completion date 1996), a multisite study to assess the potential association between paternal exposure to ionizing radiation and the risk of leukemia in offspring of exposed male workers, a study of neurologic health outcomes in workers exposed to high levels of mercury between 1953 and 1963, studies of mortality among ORR workers, a multisite study of mortality among female nuclear workers, a multisite exposure assessment of hazardous waste/cleanup workers, a chronic beryllium disease study, and a multisite study of heat stress and performance among carpenters.

E.4.3 Savannah River Site

SRS, established in 1953 in Aiken, SC, produces plutonium, tritium, and other nuclear materials. There are reports that millions of curies of tritium have been released over the years both in plant exhaust plumes and in surface and groundwater streams (ED 1982a:135-152).

Surrounding Communities. In 1984, Sauer and Associates examined mortality rates in Georgia and South Carolina by distance from the Savannah River Plant (now known as SRS) (SR duPont 1984b). Rates for areas near the plant were compared with U.S. rates and with rates for counties located more than 80-km (50-mi) away. Breast cancer, respiratory cancer, leukemia, thyroid cancer, bone cancer, malignant melanoma of the skin, nonrespiratory cancer, congenital anomalies or birth defects, early infancy death rates, stroke, or cardiovascular disease in the populations living within 80 km (50 mi) of the plant did not show any excess risk compared with the reference populations.

State Health Agreement Program. Under the State Health Agreement Program managed by DOE's Office of Epidemiologic Studies, a grant was awarded to the Medical University of South Carolina in 1991 to develop the Savannah River Region Health Information System. The purpose of the Savannah River Region Health Information System database was to assess the health of populations surrounding SRS by tracking cancer rates and birth defects rates in the area. Information from the registry is available to public and private health care providers for use in evaluating cancer control efforts. A steering committee provides advice to the Savannah River Region Health Information System and communicates public concerns to the System. It consists of 12 community members and persons with technical expertise representing South Carolina and Georgia. The meetings are open to the public.

Workers. A descriptive mortality study was conducted that included 9,860 white male workers who had been employed at lease 90 days at the Savannah River Plant between 1952 and the end of 1974 (AJIM 1988b:379-401). Vital status was followed through the end of 1980 and mortality was compared with the U.S. population. SMRs were computed separately for hourly and salaried employees. For hourly employees, nonstatistically significant increases were seen for cancer of the rectum (SMR - 1.09, 5 observed), cancer of the pancreas (SMR - 1.08, 10 observed), leukemia and aleukemia (SMR - 1.63, 13 observed), other lymphatic tissue (SMR - 1.06, 5 observed), benign neoplasms (SMR - 1.33, 4 observed), and motor vehicle accidents (SMR - 1.10, 63 observed). Salaried employees exhibited nonstatistically significant increases in cancer of the liver (SMR - 1.84, 3 observed), cancer of the prostate (SMR - 1.35, 5 observed), cancer of the bladder (SMR - 1.87, 4 observed), brain cancer (SMR - 1.06, 4 observed), leukemia and aleukemia (SMR - 1.05, 4 observed), and other lymphatic tissue (SMR - 1.23, 3 observed). No trends between increasing duration of employment and SMRs were observed. A statistically significant excess of leukemia deaths was observed for hourly workers employed at least 5, but less than 15 years (SMR - 2.75, 6 observed). Review of the plant records and job duties of the workers who died from leukemia indicated that two of the cases had potential routine exposure to solvents, four had potential occasional exposure to solvents, and one had potential for minimal exposure. Benzene, a known carcinogen, was reportedly not used at the plant.

Epidemiologic Studies. DOE's Office of Epidemiologic Studies has implemented an Epidemiologic Surveillance Program at SRS to monitor the health of current workers. This program will evaluate the

occurrence of illness and injury in the workforce on a continuing basis, and the results will be issued in annual reports. The implementation of this program will facilitate an ongoing assessment of the health and safety of the SRS workforce and will help identify emerging health issues.

Epidemiologic surveillance, which is currently operational at a number of DOE sites, including production sites and research and development (R&D) facilities, uses routinely collected health data, including descriptions of illness resulting in absences lasting 5 or more consecutive workdays, disabilities, and OSHA-recordable injuries and illnesses abstracted from the OSHA 200 log. These health event data, coupled with demographic data about the active workforce at the participating sites, are analyzed to evaluate whether particular occupational groups are at increased risk of disease or injury when compared with other workers at a site. As the program continues and data for an extended period of time become available, time trend analysis will become an increasingly important part of the evaluation of worker health. Monitoring the health of the workforce provides a baseline determination of the illness and injury experience of workers and a tool for monitoring the effects of changes made to improve the safety and health of workers. Noteworthy changes in the health of the workforce may indicate the need for more detailed study or increased health and safety measures to ensure adequate protection for workers.

Memorandum of Understanding. DOE entered into a Memorandum of Understanding with the Department of Health and Human Services to conduct health studies at DOE sites. The Centers for Disease Control and Prevention's National Center for Environmental Health is responsible for dose reconstruction studies and the National Institute for Occupational Safety and Health is responsible for worker studies. These activities are funded by DOE.

A study of mortality among SRS workers employed from 1952 to 1974 to examine whether risks of death due to selected causes may be related to occupational exposures at SRS is being conducted by the National Institute for Occupational Safety and Health. SRS is also included in several multisite studies managed by the institute. The first study is to assess the potential association between paternal work-related exposure to ionizing radiation and the risk of leukemia in offspring of exposed male workers. The second study is to examine causes of death among female workers at nuclear weapons facilities to develop risk estimates based on exposures to external and internal ionizing radiation and to hazardous chemicals. A third multisite project is a case-control study of multiple myeloma, a type of blood cell cancer.

A dose reconstruction project around SRS is being conducted by the National Center for Environmental Health to determine the type and amount of contaminants to which people living around the site may have been exposed, to identify exposure pathways of concern, and to quantify the doses people may have received as a result of SRS operations. The estimated completion date is 1999 or 2000.

E.4.4 Kansas City Plant

Surrounding Communities. No known epidemiologic studies have been conducted in the surrounding communities to date.

Epidemiologic Surveillance. DOE's Office of Epidemiologic Studies has implemented an Epidemiologic Surveillance Program at the Kansas City Plant to monitor the health of current workers. This program will evaluate the occurrence of illness and injury in the workforce on a continuing basis and annual reports will be issued reporting the results of the ongoing surveillance. The implementation of this program currently supports the automation of occupational medical data management at the site to facilitate electronic access to key information used in surveillance. The program will facilitate an ongoing assessment of the health and safety of the site's workforce and help to identify any emerging health issues in a timely manner.

Currently operational at a number of DOE sites, including production sites and R&D laboratories, epidemiologic surveillance makes use of routinely collected health data, including reasons for illness, absence lasting 5 or more consecutive workdays, disabilities, and OSHA-recordable injuries and illnesses abstracted from the OSHA 200 log. These health event data, coupled with demographic data about the active workforce at the participating sites, are analyzed to evaluate whether particular occupational groups are at increased risk of disease or injury when

compared with other workers at a site. As the program continues and data become available for an extended period of time, trend analysis will become an increasingly important part of the evaluation of worker health. Monitoring for changes in the health of the workforce provides both a baseline determination of the illness and injury experience of workers and a tool for monitoring the effects of changes made to improve the safety and health of workers. Epidemiologic surveillance also provides an early warning of noteworthy changes in health and safety that may indicate areas in need of additional, more-detailed study or increased health and safety measures to ensure adequate protection for workers.

E.4.5 Pantex Plant

Surrounding Communities. A June 1994 study by the Texas Cancer Registry, Texas Department of Health, showed significant increases in prostate cancer mortality among Potter County and Randall County males, and leukemia mortality among Carson County males during the period between 1981 and 1992 (TX DOH 1994a). There were no statistically significant increases observed in site-specific cancer mortality among females during this period. For cancer incidence during the period between 1986 and 1992, no statistically significant excesses in males were seen; however, cancer of the prostate was slightly elevated in Potter/Randall County males. Analysis of the four major cell-specific types of leukemia, showed a significant excess in the incidence of chronic lymphocytic leukemia among Potter/Randall County females. This study was conducted in Carson, Potter, and Randall Counties, which are located near Pantex. This study focused only on cancers of the breast, prostate, brain, thyroid, and leukemia, which were of specific concern to citizens in the area. Other radiation-associated cancers, such as bone and lung, were not included in this study. Although prostate cancer and chronic lymphocytic leukemia have not been linked to radiation exposure, further followup to this study was recommended.

Workers. An epidemiologic study of Pantex workers was published by Acquavella (HP 1985b:735-746). This study compared total and cause-specific mortality for Pantex workers employed between 1951 and December 31, 1978, with expected cause-specific mortalities based on U.S. death rates. Significantly fewer deaths were observed in the workforce than would be expected based on U.S. death rates for the following causes of death: all cancers, arteriosclerotic heart disease, and digestive diseases. No specific causes of death occurred significantly more frequently than expected. Slightly elevated mortality ratios were observed for brain cancer and leukemia; neither excess was statistically significant. The four deaths from brain cancer all occurred among those who had worked at the plant less than 5 years. The four deaths from leukemia occurred with equal frequency among those who had worked at the plant a short time and those who had worked more than 15 years.

Memorandum of Understanding. A followup of the 1985 mortality study of the Pantex workforce is planned. The update will be conducted by the National Institute for Occupational Safety and Health as part of a research program funded by DOE under a Memorandum of Understanding with the Department of Health and Human Services. The followup study is scheduled to commence either in late 1996 or early 1997. In addition, female workers at Pantex will be included in a National Institute for Occupational Safety and Health funded multisite study of mortality among female nuclear weapons workers.

Epidemiologic Surveillance. DOE's Office of Epidemiologic Studies Epidemiologic Surveillance Program was implemented at Pantex in 1993 in order to monitor the health of current workers. This program evaluates the occurrence of illness and injury in the workforce on a continuing basis and issues the results of the ongoing surveillance in annual reports. The program facilitates an ongoing assessment of the health and safety of the site's workforce and helps to identify any emerging health issues in a timely manner. Monthly data collection began on January 1, 1994, and the results of the first complete year of epidemiologic surveillance will be presented to workers and other site stakeholder groups in spring 1996.

Currently operational at a number of DOE sites, including production sites and R&D laboratories, epidemiologic surveillance makes use of routinely collected health data including descriptions of illness resulting in absences lasting 5 or more consecutive workdays, disabilities, and OSHA-recordable injuries and illnesses abstracted from the OSHA 200

log. These health event data, coupled with demographic data about the active workforce at the participating sites, are analyzed to evaluate whether particular occupational groups are at increased risk of disease or injury when compared with other workers at a site. As the program continues and data become available for an extended period of time, trend analysis will become an increasingly important part of the evaluation of worker health. Monitoring for changes in the health of the workforce provides both a baseline determination of the illness and injury experience of workers and a tool for monitoring the effects of changes made to improve the safety and health of workers. Noteworthy changes in the health of the workforce may indicate areas in need of more detailed study or increased health and safety measures to ensure adequate protection for workers.

E.4.6 Los Alamos National Laboratory

Los Alamos and adjacent counties comprise a unique setting and history. LANL, for much of its existence, was a closed community where most of the residents had direct economic ties to the laboratory. Nearly all male residents and some of the female residents are employed at LANL. Medical care in Los Alamos County had been centralized at the laboratory and a single community hospital. This is a unique, highly educated community situated adjacent to lands populated by Native Americans.

Surrounding Communities. Selected cancer mortality and incidence (newly diagnosed cancer) rates between 1950 and 1969, for 11 selected cancers among white males in Los Alamos County were compared with rates for the State of New Mexico, U.S. rates, and with rates of five socioeconomic and occupational control counties and five high-education western counties, based on U.S. Bureau of the Census information (ER 1981a:86-105). The comparisons were made to identify cancer types that were greater than expected while taking into account important factors, such as income and education, associated with cancer patterns. Six cancer types were identified that had rates greater than cancer rates for one or more of the four comparison groups; they are: cancer of the bile ducts and liver, bladder, prostate, brain and nervous system, lympho- and reticulo-sarcoma, and leukemia. Cancer rates of the prostate, bladder, and leukemia were also greater than expected.

Compared with New Mexico white males, Los Alamos County Anglo-white males show nonstatistically significant excesses in cancer incidence from 1969 to 1974 for the stomach, colon, rectum, pancreas, lung, and bladder (ER 1981a:86-105). All cancers combined show a 35-percent statistically significant excess. Los Alamos County white females show nonstatistically significant excesses for cancers of the stomach, large intestine, lymphosarcoma and reticulasarcoma, and leukemia. All cancers combined show a statistically significant 40-percent excess.

In 1991, the New Mexico Department of Health initiated epidemiologic studies in response to citizen concerns about an apparent excess of brain tumors among residents of the western area neighborhoods of Los Alamos County as a result of historical LANL nuclear operations. The New Mexico Department of Health conducted a descriptive study of brain cancer incidence in Los Alamos County and for 22 other sites (NM DOH 1993a). The study showed that during the mid- to late-1980s an excess of approximately 80 percent of brain cancer had occurred in Los Alamos County compared with a New Mexico reference population and national statistics. The excess incidence had disproportionately occurred among persons who were residents of the western area at the time of diagnosis or death; however, there were only three cases, and they were confined to the 2-year time period, 1986 to 1987. Additional descriptive studies showed that the brain cancer rates for Los Alamos County were within the range of rates observed across New Mexico counties from 1983 to 1987 and 1988 to 1991. A review of mortality statistics for benign or unspecified neoplasms of the brain and nervous system showed no deaths from these causes in Western Area residents during 1984 to 1990.

Los Alamos County breast cancer incidence rates remained level, but higher than New Mexico rates from 1970 to 1990. Reproductive and demographic factors associated with the risk of breast cancer were thought to account for the higher rates. A special study was conducted to examine the recent increase in breast cancer since 1988 (NM DOH 1994a). The New Mexico Tumor Registry concluded that the increase seen between 1988 and 1992 was primarily due to increased detection of early stage disease.

The incidence of ovarian cancer in Los Alamos County women was elevated from the mid-1970s to 1990. From 1986 through 1990, ovarian cancer incidence in Los Alamos County was roughly two-fold higher compared with New Mexico reference population rates. The excess ovarian cancer rate was confined to a census tract corresponding to two neighborhoods and was four- to six-fold higher than that observed in the remaining Los Alamos County census tracts.

The incidence rates for melanoma (cancer of the skin) in Los Alamos County were elevated from 1970 through 1990, with peak elevations occurring from the mid- to late-1980s. There was approximately a twofold excess risk compared with a New Mexico State reference population. The excess melanoma incidence observed in Los Alamos County was thought to be related to the high ambient solar ultra-violet radiation intensity due to its high altitude.

A fourfold increase in thyroid cancer incidence during the late 1980s was noted in a study by Athas (NM DOH 1996a). A case-series records review was initiated to examine data relating to the detection, diagnosis, and known risk factors for thyroid cancer. All cases of thyroid cancer diagnosed among Los Alamos County residents between 1970 and 1995 were identified through the New Mexico Tumor Registry. The incidence rate for thyroid cancer in Los Alamos County was slightly higher than New Mexico rates between 1970 and the mid-1980s. There was a statistically significant fourfold increase during the late 1980s and early 1990s compared with the State, but the rate began to decline in 1994 and 1995.

The higher than expected number of thyroid cancer cases could not be explained by changes in diagnosis of thyroid cancer among Los Alamos County residents. Additional analyses suggested that increased medical surveillance and greater access to medical care were responsible for the recent excess in Los Alamos County.

Potential risk factors for thyroid cancer including therapeutic irradiation, genetic susceptibility, occupational radiation exposure, and weight were also examined. However, the investigation did not identify a specific cause for the elevated rate of thyroid cancer in Los Alamos County.

Male Workers. A mortality study of 224 white males with the highest internal depositions of plutonium 239 (10 nanocuries or more) at LANL were examined by Voelz et al. (LANL 1985a). Followup was through April 1980. SMRs were low for all cause of death (SMR - 0.56, 95 percent CI - 0.40-0.75), all malignant neoplasms (SMR - 0.54, 95 percent CI - 0.23-1.06), compared with U.S. white males and lung cancer (SMR - 20, 95 percent CI - 0-110).

A cohort mortality study by Wiggs et al. examined the causes of death among 15,727 white males hired at LANL between 1943 and 1977 (HP 1994a:577-588). The purpose of the study was to determine if plutonium deposition and external ionizing radiation were related to worker mortality. After nearly 30 years of followup, the LANL workforce experienced 37 percent fewer deaths from all causes, and 36 percent fewer deaths due to cancer than expected when compared with death rates for the U.S. population.

The researchers identified a subset of 3,775 workers who had been monitored for plutonium exposure; of these, 303 workers were categorized as "exposed" based on a urine bioassay for plutonium; the remainder were nonexposed. One case of rare bone cancer, osteogenic sarcoma, a type of cancer related to plutonium exposure in animal studies, was noted among the plutonium exposed group. The overall mortality and site-specific rates of cancer did not differ significantly between the two groups of workers. A nonstatistically significant increase in lung cancer among the exposed group was noted, but there was no information on cigarette use among the workers.

When researchers examined data for the 10,182 workers who were monitored for exposure to external ionizing radiation (including 245 workers exposed to plutonium) they observed a dose-response relationship for cancers of the brain/central nervous system, cancer of the esophagus, and Hodgkin's disease. When the 225 plutonium-exposed workers were excluded from the analysis, there was a statistically significant dose response between external ionizing radiation and kidney cancer and lymphocytic leukemia.

A special lifetime medical study was conducted on 26 of the workers who have the largest internal depositions of plutonium at LANL. Voelz and Lawrence reported on the 42-year followup of the 26 white males who designed and built the first atomic bomb and were determined to have had a significant deposition of plutonium-239 sometime in 1944 or 1945 based on job assignment, working conditions, and urine levels of plutonium (HP 1991a:181-190). Their mortality experience was compared to U.S. white males adjusted for age and calendar time. The mortality rates were also compared with rates for a cohort of LANL workers hired at the same time and born between the same years; no significant differences were for all cause mortality and all cancer mortality. One of the seven reported deaths was due to bone sarcoma, the most frequent radiation-induced cancer observed in persons with radium depositions.

Wiggs reported on 6,970 women employed at LANL for at least 6 months from 1943 through 1979, with deaths determined through 1981 (LA Wiggs 1987a). The mortality rates for all causes of death combined and all cancers combined were 24 and 22 percent below the rate for the U.S. population, respectively. Although the overall rates are low, women occupationally exposed to ionizing radiation have elevated rates for cancer of the ovary and of the pancreas relative to those not exposed. An unusual finding was that female radiation workers experienced a statistically significant excess of death from suicide. In a special in-depth study, the suicides were compared to two control groups, deaths from other injuries and deaths from noninjuries. History of employment as a radiation worker was significantly associated with death from suicide for both comparison groups. No significant associations for duration of employment, plutonium exposure, or martial status were seen (APHA 1988a).

As result of a reported threefold excess of malignant melanoma among laboratory workers at LLNL in California and similarities between occupational exposures and prevailing sunshine conditions at LANL and LLNL, an investigation was undertaken to assess the risk of melanoma at LANL (Lancet 1981a:712-716). Incidence data were obtained from the New Mexico Tumor Registry. No excess risk for melanoma was detected at LANL among 11,308 laboratory workers between 1969 and 1978. Six cases were identified where about 5.7 were expected (Lancet 1982a:883-884). The rate for the total cohort, Hispanic males and females, non-Hispanic males and females were not significantly different from the corresponding New Mexico rates.

A special in-depth study of 15 cases diagnosed through 1982 did not detect an association between melanoma and exposure to any type of external radiation as measured by film badges, neutron exposures, plutonium body burden based on urine samples, or employment as a chemist or physicist (HP 1983c:587-592). However, the workers with melanoma were more educated than the comparison group using the college and graduate degree as a measure of education, a finding consistent with other reports of malignant melanoma according to the authors. The numbers in this study are too small to detect any but large excesses.

Memorandum of Understanding. DOE entered into a Memorandum of Understanding with the Department of Health and Human Services to conduct health studies at DOE sites. The National Institute for Occupational Safety and Health is responsible for managing or conducting the worker studies. The following multisite studies that include LANL are currently underway: a study of mortality among female nuclear weapons workers, a case-control study of multiple myeloma, a leukemia study, and an exposure assessment of hazardous waste/cleanup workers.

E.4.7 Lawrence Livermore National Laboratory

Surrounding Communities. The California Department of Health Services released a study of cancer occurrence among children and young adults living or born in Livermore, California (CA DHS 1995a). The study specifically aimed to determine the risk of leukemia and non-Hodgkin's lymphoma among young people living near LLNL. An increased risk of these two cancers among children living near the Sellafield nuclear facility in England had been suggested by a British study (JRSS 1989a:307-325).

Investigators studied two groups of children and young adults under the age of 25: those who were born in Livermore between 1960 and 1990 and those who actually lived in Livermore between 1960 and 1991. No increased risk of leukemia or non-

Hodgkins lymphoma was detected among Livermore children living near a nuclear facility, as suggested by the British study. However, a 2.4-fold increase in the risk of malignant melanoma, a form of skin cancer which can be fatal, was found for children and young adults who lived in Livermore between 1960 and 1991 compared with youngsters who lived other places within Alameda County. An even more significant 6.4-fold increased risk of malignant melanoma was found in children born in Livermore between 1960 and 1991. The rate of melanoma was highest in those under 20 years of age. No increased risk of any other type of cancer was found. The report states that "it is not possible, within the scope of the current study, to assess whether or not melanoma cases had any affiliation with LLNL."

Workers. In 1981, a joint study undertaken by the California Department of Health Services and LLNL reported that 19 cases of malignant melanoma were observed between 1972 and 1977 among approximately 5,100 LLNL employees (Lancet 1981a:712-716). This incidence rate was significantly higher than that expected in the comparable population of the San Francisco Bay Area. Preliminary findings, however, suggested that this apparent increase in the malignant melanoma was not associated with length of employment at LLNL, nor with type of monitored radiation exposure. No other cancers were increased among LLNL employees from 1969 to 1980 (WJM 1985a:214-218).

The reasons for the malignant melanoma increase were not clear, and a series of studies was prompted to investigate the problem. A case-control study reported five occupational factors having causal relationships with the observed excess in malignant melanoma: exposure to radioactive materials, exposure to volatile photographic chemicals, Site 300 at LLNL, chemist duties based on job titles, and Pacific Test Site (LLNL 1984b). The association between melanoma and occupational factors reported in the study was criticized by Shy et al. (LLNL 1985a). A question concerning surveillance bias was also raised, because the number of cases was too small and because of the excessive number of exposure factors analyzed. The authors noted that evidence for a dose-response gradient was not provided and the biological plausibility of causal hypothesis was not established.

Various studies investigated the role of surveillance bias in relation to the elevated incidence of melanoma. Hiatt and Fireman reported that the increase among melanoma incidence is associated with increased biopsy rates for pigmented nevi in LLNL employees compared with matched controls who belonged to the same prepaid health plan but who did not work at LLNL (PM 1986a:652-660). The occupational physicians caring for LLNL employees may be more aware of the potential malignancy of pigmented lesions than those caring for non-LLNL employees. Subsequently, the increasing percentage of thin cutaneous malignant melanoma over time (1969 to 1976, 1977 to 1984, and 1984 to 1986) reported at LLNL suggests increased efforts to diagnosis cutaneous malignant melanoma early on (Lancet 1987a: 1435). The mean thickness of cutaneous malignant melanoma among LLNL employees has decreased more rapidly between 1976 and 1984 than those from the comparison laboratory (AD 1990a:967-969). On the other hand, others reported that the thinner lesions were only confirmed prior to 1976, and after 1976 there was no difference in lesion thickness (Epidemiology 1993a:43-47).

The most recent case-control study of malignant melanoma concluded that there was no association between occupational factors and the increased melanoma diagnosis among LLNL employees (LLNL 1994e). No clear explanation for the increased melanoma among LLNL workers has been provided. Increased awareness and enhanced surveillance are currently suspected, and monitoring of mortality from melanoma continues at LLNL.

Memorandum of Understanding. DOE entered into a Memorandum of Understanding with the Department of Health and Human Services to conduct health studies at DOE sites. The National Institute for Occupational Safety and Health is responsible for managing or conducting the worker studies. The Institute funded a grant to examine the industrial hygiene system at LLNL that will allow the study of complex exposure scenarios.

E.4.8 Sandia National Laboratories

Community Studies. There are no known epidemiologic studies that have been conducted which

examine the impact of SNL on the health of the surrounding communities.

Epidemiologic Surveillance. The Office of Epidemiologic Studies Epidemiologic Surveillance Program has been implemented at SNL to monitor the health of current workers at the Albuquerque site. This program monitors and evaluates the occurrence of illness and injury in the workforce on a continuing basis and annual reports are issued reporting the results of the ongoing surveillance. The program facilitates a continuing assessment of the health and safety of the site's workforce and helps to identify any emerging health issues. Refinements to epidemiologic surveillance at SNL include the anticipated addition of selected dosimetry data, enhancing the program's ability to monitor potential health effects associated with radiation exposure.

Epidemiologic surveillance makes use of routinely collected health data including reasons for illness absence lasting five or more consecutive workdays, disabilities, and OSHA-recordable injuries and illnesses abstracted from the OSHA 200 log. These health event data, coupled with demographic data about the active workforce are analyzed to evaluate whether particular occupational groups are at increased risk of disease or injury when compared with other workers at SNL. As the program continues and data become available for an extended period of time, trend analysis will become an increasingly important part of the evaluation of worker health. Monitoring for changes in the health of the workforce provides a baseline rate of illness and injury among the workers and a tool to evaluate changes in industrial hygiene and health physics practices. Epidemiologic surveillance also provides an early warning of changes in health and safety that may indicate areas in need of more detailed study or increased safety measures to ensure adequate protection for workers.

Workers. Broadwell et al. report that 25 workers, 5 currently, and 20 formerly involved in the manufacture of hybrid microcircuits, underwent clinical evaluations at the request of a management union committee concerned about chronic solvent exposures in an R&D laboratory (AJIM 1995a:677-698). A battery of neurobehavioral tests was administered to compare the solvent-exposed group with age-, ethnicity-, and education-matched controls. The tests included MMPI-I, handgrip strength, tactile sensitivity, dexterity, color discrimination, visual acuity and contrast sensitivity, and tests selected from the computerized Neurobehavioral Evaluation System. Clinical narratives and retrospective exposure assessments in the study group suggested chronic low-level exposure to solvents, with intermittent acute excursions. The most frequently reported symptoms from the clinical questionnaires were upper respiratory irritation (68 percent), poor concentration and memory loss (48 percent), depressed mood (40 percent), lower respiratory irritation (28 percent), eye irritation (28 percent), distal upper extremity paresthesia (24 percent), and skin rash (12 percent). Work-related diagnosis included upper respiratory mucosal irritation and sinusitis (44 percent), lower respiratory reactive disease (12 percent), and dermatitis (5 percent). Ten of the 25 exposed workers (40 percent) had a history of a clinical syndrome with headache, dizziness, disequilibrium, fatiguability, memory impairment, difficulty in concentration, and loss of initiative following acute solvent exposures. Solvent exposures linked to this syndrome were intermittent, and symptoms were reversible after cessation of what were reported as high-level exposures. Several exposed workers showed clinical evidence of an acquired toxic encephalopathy supporting an association between long-term solvent exposure and depressed mood, with increased somatic symptoms. Significant differences (after Bonferroni correction) were found between the two groups on the following Neurobehavioral Evaluation System subtests: finger tapping, simple reaction time, symbol digit substitution, mood scale, and symptom questionnaire. Differences also reached significance for contrast sensitivity, vibrotactile threshold, and handgrip strength. Attention to engineering controls, chemical fume hood ventilation, work practices, safety training, and personal protective gear was markedly improved when the lab was moved in the fall of 1990.

E.4.9 Nevada Test Site

Surrounding Communities. Above ground testing of nuclear weapons at NTS Test Range Complex in southern Nevada between 1951 and 1958 resulted in the dissemination of radioactive fallout over southeastern Nevada and southwestern Utah through wind dispersion. Several epidemiologic studies have been

conducted to investigate possible adverse health effects of low-level radiative fallout on residents of these states. These studies focused on leukemia and thyroid disease in children downwind of NTS.

A series of ecologic studies showed equivocal results in potentially exposed children. A cross sectional review of thyroid nodularity among teenage children reported by Weiss et al. found no significant difference in the frequency of nodules among potentially exposed and nonexposed children (AJPH 1971a:241-249). Exposure was defined in terms county of residence. Rallison et al. reported no significant difference in any type of thyroid disease between Utah children exposed to fallout radiation in the 1950s and control groups drawn from Utah and Arizona (AJM 1974a:457-463; JAMA 1975a:1069-1072).

To investigate the possible relationship between childhood leukemia and radioactive fallout, Lyon et al. conducted a mortality study of Utah children under 15 years old who died in Utah between 1944 and 1975 (NEJM 1979a:397-402). Lyon et al. selected this age group because of the reported increased susceptibility of children to the neoplastic effects of radiation and the lack of a comparison group over 14 years of age with suitable low exposures. Lyon et al. obtained death certificates from the Utah vital statistics registrar and based on year of death, categorized decedents into either high (fallout years of 1951 to 1958) or low exposure periods (combined pre-fallout years of 1944 to 1950 and post-fallout years of 1959 to 1975). From estimated fallout patterns contained in maps of 26 tests, Lyon et al. categorized 17 southern rural counties as high fallout area and the remaining northern urban counties as low fallout area. Age-specific mortality rates derived for deaths which occurred in the combined low exposure periods were compared with those in the high exposure period. For reasons unknown, leukemia mortality during the low exposure periods in high fallout counties was half that of the United States and Utah. A significant excess of leukemia occurred among children statewide who died during the high fallout period compared to those who died during the low fallout periods (SMR - 1.40, 95 percent CI - 1.08-1.82, $p<0.01$). This excess was more pronounced among those who resided in the high fallout area (SMR - 2.44, 95 percent CI - 1.18-5.03). No pattern was found for other childhood cancers in relation to fallout exposure. Actual radiation dosage was not available, and the effects of migration were not determined for this study.

Beck and Krey (Science 1983a:18-24) reconstructed exposure of Utah residents studied by Lyon et al. (NEJM 1979a:397-402) to external gamma-radiation from NTS fallout through measurements of residual cesium-137 and plutonium in soil. Beck and Krey found that residents in southwest Utah closest to NTS received the highest exposures, but noted that residents of urban northern areas received a higher mean dose and a significantly greater population dose than did residents of most counties closer to the test site. Northern Utah residents received higher average bone doses than southern Utah residents; therefore, distance from NTS should not be the sole criteria for dividing the state into geographic subgroups for the purpose of conducting epidemiologic studies. Beck and Krey concluded that bone doses to southern Utah residents were too low to account for the excess leukemia deaths identified by Lyon et al. They also determined that bone and whole body doses from NTS fallout were small relative to lifetime doses most Utah residents receive from background radiation, and that it was unlikely that these exposures would have resulted in any observed health effects.

Land et al. (Science 1984a:139-144) attempted to confirm the association between leukemia and fallout reported by Lyon et al. (NEJM 1979a:397-402) using cancer mortality data from the National Center for Health Statistics for the period 1950 through 1978. No statistically significant differences in mortality from leukemia or other childhood malignancies between northern and southern Utah were observed. The small observed difference in leukemia mortality between the border and interior counties was opposite in direction to that reported by Lyon et al. Results indicated a downward trend in childhood leukemia mortality over time. Eastern Oregon and the State of Iowa also were selected for comparison with Utah. The leukemia mortality rate for eastern Oregon was higher, and Iowa lower than the rate for Utah. Although both were not statistically significant, Land et al. concluded that these results suggest that the association reported by Lyon et al. merely reflects an unexplained low leukemia rate in southern Utah for the period 1944 to 1949.

Another study that assessed the development of cancer among individuals potentially exposed to radioactive fallout has been reported by Rallison et al. (HP 1990c:739-746). This study examined the thyroid neoplasia risk in a cohort of children born between 1947 to 1954 in two counties near nuclear test sites, one in Utah and one in Nevada. A comparison group of Arizona children presumed to have no fallout exposures was also evaluated. The children (11 to 18 years of age) were examined between 1965 to 1968 for thyroid abnormalities and were reexamined in 1985 and 1986. Children living in the nuclear testing (Utah/Nevada) area had a higher rate of thyroid neoplasia than the comparison children (in Arizona), but the differences were not statistically significant. The authors concluded that living near NTS in the 1950s has not resulted in a statistically significant increase in thyroid neoplasms.

A study by Johnson examined cancer incidence in a cohort of Mormon families in southwest Utah near the NTS (JAMA 1984b:230-236). The study compared cancer incidence among all Utah Mormons during the period 1967 to 1975 with cancer incidence among two exposed populations: persons residing in a high fallout area and an exposure effects group residing in a broader area that received less intense exposure from radioactive fallout. Limitations of the study include: the inability to locate 40 percent of the defined population, the lack of verifying the reported diagnosis of cancer, and the inability to interview a comparable control group.

Cancer incidence for both exposed groups was compared with that of all Utah Mormons for two time periods, 1958 to 1966 and 1972 to 1980. Johnson found an apparent increased incidence of leukemia and cancers of the thyroid and bone for residents of the high fallout area for both time periods (p - 0.01). Additional analyses suggested that a higher proportion of the cancers among exposed groups were in radiosensitive tissues and the proportional excess increased with time compared with all Utah Mormons. The ratio of radiosensitive cancers to all other cancers from 1958 to 1966 was 24 percent higher among the high fallout area group and 29.6 percent higher among those in the fallout effects group. For 1972-80, the ratio was 53.3 percent higher in the high fallout area group and 300 percent higher in the fallout effects group.

Machado examined cancer mortality rates of a three-county region in southwestern Utah in comparison to the remainder of Utah (AJE 1987c:44-61). There was no excess risk of cancer mortality in southwest Utah, with the exception of leukemia, which showed a statistically significant excess for all ages combined, and for children age 0 to 14. In fact, mortality from all cancer sites combined was lower in southwest Utah than the remainder of the state. The authors noted that their findings, including those for leukemia, were inconsistent with the cancer incidence study conducted by Johnson (JAMA 1984b:230-236).

Archer measured soil, milk, and bone strontium-90 levels to identify states with high-, intermediate-, and low-fallout contamination (AEH 1987a:263-271). He then correlated the deaths from radiogenic and nonradiogenic leukemias with the time periods of aboveground nuclear testing both in the United States and Asia. The results show that leukemia deaths in children were higher in states with high exposure and lower in states with less exposure. He showed that leukemia deaths in children peaked approximately 5.5 years following nuclear testing peaks. The last leukemia peak in the United Sates occurred from 1968 to 1969, 5.5 years after the last year of a 3-year period of intensive testing in Asia. The increases were seen in the radiogenic leukemias (myeloid and acute leukemias), and not with all other leukemias.

Kerber et al. updated a previously identified cohort of children living in portions of Utah, Nevada, and Arizona, to estimate individual radiation doses and determine thyroid disease status through 1985 to 1986 (JAMA 1993a:2076-2082). Of the 4,818 children originally examined between 1965-70, 2,473 were included in the followup exam. Outcomes of interest included thyroid cancers, neoplasms, and nodules based on physical examinations of the thyroid. Exposure of the thyroid to radioiodines was based on radionuclide deposition rates provided by DOE and surveys of milk producers. Children with questionable findings were referred to a panel of endocrinologists for further examination. The authors reported an excess number of thyroid neoplasms (combined benign and malignant) and a positive dose-response trend for neoplasms, both of which were statistically significant. The authors also reported a positive dose-response trend for thyroid nodules, not statistically significant, and a positive

dose-response trend for thyroid carcinomas with marginal statistical significance. The authors estimated that an excess of between 1 and 12 neoplasms (between 0 to 6 excess malignancies) was probably caused by exposure to radioiodines from the nuclear weapons testing. A letter to the editor criticized Kerber et al. for relying on food histories obtained 22 years after the fact to depict radioiodine intake, and for the untested modeling approach for determining dose to the thyroid (JAMA 1994a:825-826). These concerns were addressed by Kerber et al., which acknowledged the uncertainties in the dose estimates, but concluded that their estimates were conservative (JAMA 1994b:826).

Till et al. estimated doses to the thyroid of 3,545 subjects who were exposed to radioiodine fallout from NTS (HP 1995a:472-483). The U.S. Public Health Service first examined this cohort for thyroid disease between 1965 to 1970 and later in 1985 to 1986. Till et al. assigned individual doses based on age, residence histories, dietary histories, and lifestyle. Individualized dose and uncertainty was combined with the results of clinical examinations to determine the relationship between dose from NTS fallout and thyroid disease incidence.

Workers. Military personnel and civilian employees of the Department of Defense observed and participated in maneuvers at the NTS Test Range Complex during above ground tests. An excess number of leukemia cases was reported (9 cases, 3.5 expected) among the 3,224 men who participated in military maneuvers in August 1957 at the time of the nuclear test explosion "Smoky" (JAMA 1980a:1575-1578). The participants were located and queried on their health status, diseases, or hospitalizations as of December 1981. Various Federal records systems were linked, including clinical files, and next of kin were queried about cause of death for those participants who were deceased. Exposure information was available from film badges records, and the mean gamma dose for the entire cohort was 466.2 mrem. In a later report of the same cohort, the number of incident cases of leukemia had increased to 10 with 4 expected (JAMA 1983a:620-624). No excess in "total cancers" was observed, however. In addition, four cases of polycythemia vera were reported where 0.2 was expected (JAMA 1984a:662-664). The excess in leukemia cancer incidence and mortality appear to be limited to the soldiers who participated in "Smoky."

The leukemia excess was not observed in a National Research Council mortality study of soldiers exposed to five series of tests at two sites: Nevada Test Site (PLUMBBOB) and the Pacific Proving Ground (DOE 1985b; NAS 1985a). The National Research Council reported that the number of leukemia cases in "Smoky" was greater, but the increase was considered nonsignificant when analyzed with the data from the other four tests. In 1989, however, it was discovered that the roster of the atomic veterans cohort on which the National Research Council based its 1985 study contained misclassification errors. As a result, this study is being reanalyzed, and the National Research Council anticipates publishing the new results by 1997.

APPENDIX F

Appendix F

APPENDIX F: FACILITY ACCIDENTS

F.1 Evaluation Methodologies and Assumptions

F.1.1 Introduction

The potential for facility accidents and the magnitudes of their consequences are important factors in evaluating the stockpile stewardship and management alternatives addressed in this programmatic environmental impact statement (PEIS). The health risk issues are twofold:

- Whether accidents at any of the individual stockpile stewardship and management facilities (or reasonable combinations thereof) pose unacceptable health risks to workers or the general public.

- Whether alternative locations for stockpile stewardship and management facilities (or reasonable combinations thereof) can provide lesser public or worker health risks. These lesser risks may arise either from a greater isolation of the site from the public or from a reduced frequency of such external accident initiators as seismic events, and aircraft crashes.

Guidance for implementing Council on Environmental Quality regulation, 40 Code of Federal Regulations 1502.22, as amended (51 FR 15618), requires the evaluation of impacts which have low probability of occurrence but high consequences if they do occur; thus, facility accidents must be addressed to the extent feasible in this PEIS. Further, public comments received during the scoping process clearly indicated the public's concern with facility safety and consequent health risks and the need to address these concerns in the decision-making process.

For the No Action case, potential accidents are defined in existing facility documentation, such as safety analysis reports, hazards assessment documents, *National Environmental Policy Act* (NEPA) of 1969 documents, and probabilistic risk assessments. The accidents include radiological and chemical accidents that produce high consequences but have a low likelihood of occurrence, and a spectrum of other accidents that have a higher likelihood of occurrence and lesser consequences than the high consequence accidents. The data in these documents includes accident scenarios, probabilities, materials at risk, source terms (quantities of hazardous materials released to the environment), and consequences.

For new, modified, or upgraded stockpile stewardship and management facilities, the identification of accident scenarios and associated data would normally be a product of safety analysis reports performed on completed facility designs. However, facility designs have not been completed for the alternatives analyzed in the programmatic portion of this PEIS. Accordingly, the accident information developed for this PEIS has been developed based upon existing information for similar facilities. The likelihood and consequences of accidents (which are site dependent) are recomputed for each of the stockpile stewardship and management proposed sites where a facility may be located. This calculation reflects the effects of such site parameters as population size and distribution, meteorology, and distance to the site boundary.

This analysis also acknowledges, semi-quantitatively, the differences in likelihood of accident initiators at specific sites (e.g., aircraft impacts, beyond design basis seismic events, and so forth), as well as qualitatively discussing the opportunities for risk reduction afforded by the potential incorporation of new technologies, processes, or protective features in the stockpile stewardship and management facilities that will enhance public health and safety over the existing facilities.

Subsequent to this PEIS, evaluation of the specific benefits achieved by such measures would be presented in the tiered project-specific NEPA document for each facility. Also, for each

facility, a Hazards Analysis Document that identifies and estimates the effects of all major hazards that have the potential to impact the environment, workers, and the public would be issued in conjunction with the Conceptual Design Package. Additional accident analyses for identified major hazards would be provided in a Preliminary Safety Analysis Report (SAR) to be issued during the period of Definitive Design (Title II) Review. A Final SAR would be prepared during the construction period and issued before testing begins as final documented evidence that the new facility can be operated in a manner that does not present any undue risk to the health and safety of workers and the public.

The accident scenarios chosen to represent the impacts for each alternative were arrived at through a screening process based on a larger set of accidents presented in existing safety documentation for similar facilities. Documents such as those shown in table F.1.1–1 were reviewed for applicable accident scenarios and data. The process sought to identify a bounding accident in each of several classes of events (e.g., fire, explosion, spill, mechanical, criticality, natural phenomena initiators, and external initiators) applicable to the alternative. The process also sought to identify bounding accidents over the spectrum of high to low probability of occurrence in order to include high-consequence/low-probability and low-consequence/high-probability accidents. These accidents are generally referred to as beyond evaluation basis accidents and evaluation basis accidents, respectively. In accordance with Department of Energy (DOE) NEPA Guidelines, beyond evaluation basis accidents are generally in the probability of occurrence range of 10^{-7} to 10^{-6} per year (yr), and evaluation basis accidents generally have a probability of occurrence greater than 10^{-6}/yr. These two designations are used only if formal SARs have not been prepared. In cases where SARs have been prepared, they are the source documents for two equivalent designations "beyond design basis accidents" and "design basis accidents." Based on discussions and meetings with experts, including a workshop, the accident scenarios were modified to reflect expected stockpile management facility conditions. For example, the material at risk identified in a safety report for a similar facility was adjusted to reflect the material at risk applicable to the Stockpile Stewardship and Management Program. A complete description of the development of accident scenarios for the alternativ a topical report (HNUS 1996a).

For each alternative, a number of beyond evaluation basis accidents h fied and are generally referred to as set of accidents." Two subsets of th are also referred to as the "composi tion basis accidents" and the "co beyond evaluation basis accidents presented for the composite set of ac the combined impacts of evaluation b evaluation basis accidents. The i composite set of evaluation basis ac provided to reflect the impacts quency/low-consequence accidents the composite set of beyond ev accidents are provided to show t low-frequency/high-consequence acc tion basis accidents are generally range greater than 10^{-6}/yr, while bey basis accidents are generally in a frec 10^{-7} to 10^{-6}/yr. In some cases, acci 10^{-7} are included in the composite set uation basis accidents to provide infc relevant to decisionmaking and that o not be considered.

For each alternative, each accident estimate its risk (i.e., mathematical accident's probability of occurrence dent's consequences) and consequenc fatalities) to a noninvolved worker, a public at the site boundary and the pc 80 kilometers (km) (50 miles [mi]) fro The estimated risks for the composite analyzed for the alternative are m combined to obtain an average risk (c per year) and consequences (cancer fa that the accidents occurred. The data accidents used to calculate the compo provided in section F.2.

F.1.2 Safety Design Process

One of the major design goals for stoc ship and management facilities is reduced risk to workers and the public associated with similar facilities in Nuclear Weapons Complex. Signifi exist between stockpile stewardship

TABLE F.1.1-1.—*Source Documents Reviewed for Applicable Accident Scenarios* [Page 1 of 3]

Item Number	Title	Site	Report Number	Date Published
01	"The Continued Operation of the Pantex Plant & Associated Storage of Nuclear Weapon Components EIS" Safety Information Document	Pantex	Draft Rev. 2	January 1995
02	Stockpile Stewardship and Management/PEIS Expanded Data Call Addendum to the Alternative Report for "Pit Manufacturing at Los Alamos National Laboratory"	LANL	none	June 1995
03	Stockpile Stewardship and Management/PEIS Expanded Data Call Addendum to Alternative Report for "Pit Manufacturing at Los Alamos National Laboratory"	LANL	LA-UR-95-2670	Sept. 1995
04	Appendix D "Accident Analysis"	LLNL	Volume II	Feb. 1992
05	Stockpile Stewardship and Management PEIS "Canned Secondary Assembly and Case Manufacturing Facility" Data Report Chapter 8 - Design Process for Accident Mitigation	LLNL	SST 95-07-006 Revision 1	July 17, 1995
06	Draft EIS and EIR for "The Continued Operation of Lawrence Livermore National Laboratory & Sandia National Laboratories, Livermore" **Unclassified Controlled Nuclear Information**	Sandia/LLNL	Volume 1 DOE/EIS - 0157 SCH90030847	Feb. 1992
07	Preliminary Draft EIS "The Continued Operation of the Pantex Plant & Associated Storage of Weapons Components" **Unclassified Controlled Nuclear Information**	Pantex	DOE/EIS 0225 DEIS Vol.1 & 2	Sept. 1995
08	EA for the "Proposed Interim Storage of Enriched Uranium Above the Maximum Historical Storage Level at the Y-12 Plant, Oak Ridge, Tennessee"	Y-12	DOE/EA-0929	Sept. 1994
09	"Basis for Interim Operation for the Pantex Plant, Amarillo, Texas"	Pantex	none	June 1995
10	"Revision 2 of the Basis for Interim Operation for TA-55-4"	LANL	ESH-3:94-105	June 1994
11	"Submittal of Revised JCO for CMR Facility" **Unclassified Controlled Nuclear Information**	LANL	none	Feb. 1995
12	"Accident/Event Analysis" (Safety Information Document)	Pantex	Draft-Rev. 2	Jan. 1995
13	"CMR Facility (SM-29) Final Safety Analysis Report" **Unclassified Controlled Nuclear Information**	LANL	CMR-FAC-94-001	Feb. 1994
14	Executive Summary - "Hazards Analysis of the Los Alamos National Laboratory Plutonium Facility (TA-55)" **Unclassified Controlled Nuclear Information**	LANL	TA-55 FSAR	July 13, 1995

TABLE F.1.1–1.—*Source Documents Reviewed for Applicable Accident Scenarios*

Item Number	Title	Site	Report Number	
15	Stockpile Stewardship and Management/PEIS "Alternative Report for Pit Manufacturing at SRS" **Unclassified Controlled Nuclear Information**	SRS	NMP-PLS-950176	
16	Draft Safety Analysis Report for "The Device Assembly Facility at the Nevada Test Site" **Unclassified Controlled Nuclear Information**	NTS	DAF SAR-001-193-5394C	
17	"U.S. Department of Energy Defense Programs Safety Survey Report" Volume III: Appendix B - Uranium Facilities **Unclassified Controlled Nuclear Information**	DOE	DOE/DP/70056-HI	
18	"U.S. Department of Energy Defense Programs Safety Survey Report" Volume I: Main Report **Unclassified Controlled Nuclear Information**	DOE	DOE/DP/70056-HI	
19	"U.S. Department of Energy Defense Programs Safety Survey Report" Volume II: Appendix A - Plutonium Facilities **Unclassified Controlled Nuclear Information**	DOE	DOE/DP/70056-HI	
20	"U.S. Department Of Energy Defense Programs Safety Survey Report" Volume VI: Appendix E - Spent-fuel Handling Facilities **Unclassified Controlled Nuclear Information**	DOE	DOE/DP/70056-HI	J
21	"TA-55 Final Safety Analysis Report" Volume I **Unclassified Controlled Nuclear Information**	LANL	TA-55-PRD-108-01.0	J
22	"TA-55 Final Safety Analysis Report" Volume II **Unclassified Controlled Nuclear Information**	LANL	LA-CP-95-169	J
23	"TA-55 Hazard Analysis" **Unclassified Controlled Nuclear Information**	LANL	LA-CP-94-0076	J
24	"Nuclear Explosive Facilities Final Safety Analysis Report Nuclear Explosive Cells Module" (Buildings 12-44 Cells 1-6, 12-85, 12-96, and 12-98) **Unclassified Controlled Nuclear Information**	Pantex	Volume 1 - Draft B	Ji
25	"Nuclear Explosive Facilities Final Safety Analysis Report Nuclear Explosive Cells Module" (Buildings 12-44 Cells 1-6, 12-85, 12-96, and 12-98) **Unclassified Controlled Nuclear Information**	Pantex	Volume 2 - Draft B	Ji
26	"Chemical High Explosives Hazards Assessment for the Pantex Plant, Amarillo, Texas"	Pantex	none	O
27	(Data Call) Tab D: "Facility Operations" **Unclassified Controlled Nuclear Information**	Y-12	OR-9183	no

TABLE F.1.1–1.—*Source Documents Reviewed for Applicable Accident Scenarios* [Page 3 of 3]

Item Number	Title	Site	Report Number	Date Published
28	"Nuclear Explosive Facilities Final Safety Analysis Report Nuclear Explosive Bays Module" (Buildings 12-64, 12-84, 12-99, and 12-104) **Unclassified Controlled Nuclear Information**	Pantex	Rev. 1 Draft 2 Volume 1	Dec. 1994
29	"Nuclear Explosive Facilities Final Safety Analysis Report Nuclear Explosive Bays Module" (Buildings 12-64, 12-84, 12-99, and 12-104) **Unclassified Controlled Nuclear Information**		Rev. 1 Draft 2 Volume 2	Dec. 1994
30	"Preliminary Safety Analysis Report Special Nuclear Materials Component Staging Facility" **Unclassified Controlled Nuclear Information**	Pantex	none	April 1989
31	"Safety Analysis Report - On-Site Transportation" **Unclassified Controlled Nuclear Information**	Pantex	Draft B	Sept. 1995
32	Stockpile Stewardship and Management/PEIS "Assembly/disassembly Nevada Test Site Alternative"	NTS	Volume 1	Aug. 4, 1995
33	Appendix 11-K - Release Fraction Data, Appendix 11-J - Consequence Equations Used in the Accident Analysis, Appendix 11-F - Seismic Accident Analysis, Appendix 11-E - Derivation of Data Values Used in the Accident Analysis **Unclassified Controlled Nuclear Information**	LANL	CMR-FAC-94-001	Feb., 1994
34	Draft "Design Process for Accident Mitigation" **Pit Disassembly and Conversion Facility Unclassified Controlled Nuclear Information**	LANL	Section 8	Aug. 21, 1995
35	"U.S. Department of Energy Defense Programs Safety Survey Report" Volume V: Appendix D - Laboratory Facilities **Unclassified Controlled Nuclear Information**	DOE	DOE/DP/70056-HI	Nov. 1993

ment facilities and the current facilities design criteria and safety standards, which will reduce total risk to the public. These changes include design to current DOE structural and safety criteria; smaller throughput, batch size and inventories of certain hazardous materials; and elimination of some hazardous materials. This will reduce potential offsite health effects if an accidental release were to occur.

Stockpile stewardship and management facilities will be designed to comply with current Federal, state, and local laws; DOE orders; and industrial codes and standards. As a result, a facility will be provided that is highly resistant to the effects of natural phenomena, including earthquake, flood, tornado, high wind, as well as credible events appropriate to the site, such as fire and explosions, and manmade threats to its continuing structural integrity for containing hazardous materials. The facilities will be designed to maintain their continuing structural integrity in the event of any credible accident or event, including an aircraft crash, if credible at these sites.

The design process for new and modified stockpile stewardship and management facilities will comply with the requirements for safety analysis and evaluation in DOE O 430.1, *Life-Cycle Asset Management* and DOE Order 5480.23, *Nuclear Safety Analysis Reports*. Safety assessment is required to be an integral part of the design process to ensure compliance with all DOE safety criteria by the time that the facilities are constructed and in operation.

For new facilities, the safety analysis process begins early in conceptual design by identifying hazards with the potential to produce unacceptable safety consequences to workers or the public. As the design develops, failure mode and effects analyses are performed to identify events that have the potential to release hazardous material. The kinds of events considered include equipment failure, spills, human error, fire and explosions, criticality, earthquake, electrical storms, tornado, flood, and aircraft crash. These postulated events become focal points for design changes or improvements to prevent unacceptable accidents. These analyses continue as the design progresses to assess the need for safety equipment and to assess the performance of this equipment in accident mitigation. Eventually, the safety analyses are formally documented in an SAR and/or in a probabilistic risk assessment. The probabilistic risk assessment documents the estimated frequency and consequence for an entire spectrum of accidents and helps to identify design improvements that could make meaningful safety improvements.

The first SAR is completed at the conclusion of conceptual design and includes identification of hazards and some limited assessment of a few enveloping design basis accidents. This analysis includes deterministic safety analysis and failure modes and effects analysis of major systems. A detailed, comprehensive Preliminary SAR is completed by the completion of preliminary design and provides a broad assessment of the range of design basis accident scenarios and the performance of equipment provided in the facility specifically for accident consequence mitigation. A limited probability risk assessment may be included in that analysis.

The SAR continues to be developed during detailed design. The safety review of this report and any supporting probabilistic risk assessment is completed and safety issues resolved before the facility construction is initiated. There is also a Final SAR produced that documents safety-related design changes during construction and the impact of those changes on the safety assessment. It also includes the results of any safety-related research and development that has been performed to support the safety assessment of the facility. Final approval of the Final SAR is required before the facility is allowed to commence operation.

F.1.3 Analysis Methodology

F.1.3.1 *Introduction*

The MELCOR Accident Consequence Code System (MACCS) was used to estimate the radiological consequences of all stockpile stewardship and management facilities for all accidents. The CHEMS-PLUS (*CHEMS-PLUS, Enhanced Chemical Hazard Evaluation Methodologies*, Arthur D. Little, Inc., July 1988) computer code was used to estimate the consequences of nonradiological accidents. A discussion of the MACCS code is provided in section F.1.3.2. A detailed description of the MACCS model is available in a three volume report: *MELCOR Accident Consequence Code System* (MACCS), NUREG/CR-4691, SAND 86-1562, February 1990.

F.1.3.2 *MELCOR Accident Consequence Code System*

MACCS models the offsite consequences of an accident that releases a plume of radioactive materials to the atmosphere. Should such an accidental release occur, the radioactive gases and aerosols in the plume would be transported by the prevailing wind while dispersing in the atmosphere. The environment would be contaminated by radioactive materials deposited from the plume, and the population would be exposed to radiation. The objectives of a MACCS calculation are to estimate the range and probability of the health effects induced by the radiation exposures not avoided by protective actions.

In order to understand MACCS, one must understand its two essential elements: the time scale after an accident is divided into various "phases" and the region surrounding the facility is divided into a polar-coordinate grid.

The time scale after the accident is divided into three phases: emergency phase, intermediate phase, and

The emergency phase begins imme-
ıccident and could last up to seven
the accident. In this period, the
lation to both radioactive clouds and
und is modeled. Various protective
specified for this phase, including
ring, and dose-dependent relocation.

: phase can be used to represent a
. evaluations are performed and
de regarding the type of protective
hat need to be taken. In this period,
ɔuds are assumed to be gone, and the
thways are those from the contami-
ıe only protective measure that can
ıis period is temporary relocation.

ıase represents all time subsequent
iate phase. The only exposure
ered here are those resulting from
ł ground. A variety of protective
aken in the long-term phase in order
to acceptable levels: decontamina-
and condemnation of property.

l used to represent the region is
acility itself. The user specifies the
divisions as well as their endpoint
to 35 of these divisions may be
ng out to a maximum distance of
mi). The angular divisions used to
grid correspond to the sixteen direc-
ıass.

ɜncy phase calculations use highly
:sponse models for early fatality and
necessary for those calculations to
a finer grid than the calculations of
ɜ and long-term phases. For this
ımpass sectors are divided into 3, 5,
d subdivisions in the calculations of
ıase.

ikelihood (probability) of cancer
ber of the public is taken as 5.0×10^{-4}
person-rem for values of dose less
or larger doses, when the rate of
ɜater than 10 rads per hour, the
ıood of cancer fatality is doubled.
ɔde was applied in a probabilistic
weather bin sampling technique.

Centerline doses as a function of distance were calculated for each of 150 meteorological sequence samples; the mean value of these doses and increased likelihoods of cancer fatality for the distance corresponding to the location of the maximum offsite individual at each site were reported for that individual. Doses to noninvolved workers were calculated similarly, except that these workers will experience an increased likelihood of cancer fatality of 4.0×10^{-4} times the dose in person-rem for doses less than 20 rem or exposure rates less than 10 rads per hour. For larger doses, when the rate of exposure is greater than 10 rads per hour, the increased likelihood of cancer fatality is doubled.

The hypothetical worker was placed at 1,000 meters (m) (3,281 feet [ft]) or at the site boundary, whichever is less. It should be noted that since the doses and cancer fatalities for the maximum offsite individual and the workers reported in the high-consequence/low-probability accident tables are mean values based on approximately 100 meteorological sequence samples, there is no direct correlation between the mean value of dose and the mean value of cancer fatalities.

Offsite population doses and latent cancer fatalities are calculated by MACCS using a methodology similar to that described for the maximum offsite individual. In the case of the population, each of the sampled meteorological sequences was applied to each of the 16 sectors (accounting for the frequency of occurrence of the wind blowing in that direction). Population doses are the sum of the individual doses in each sector. Once again, the mean value of the calculated population doses and latent cancer fatalities for each of the trials are reported.

F.2 Stockpile Management

F.2.1 Weapons Assembly/Disassembly

Studies of evaluation basis accidents (EBA) and beyond evaluation basis accidents (BEBA) have been performed for the downsized weapons assembly/disassembly (A/D) operations. The studies postulated a set of accident scenarios that were representative of the risks and consequences for workers and the public from operations. Although not all potential accidents were addressed, those that were postulated have consequences and risks that are expected to envelop the consequences and risks of an operating facility.

The accident analyses in this PEIS have been closely coordinated with the Pantex Site-Wide EIS to ensure consistency. The Pantex Site-Wide EIS is a more detailed evaluation of the Pantex Plant (Pantex) operations than this PEIS. Consequently, if there are any differences between the two documents, this PEIS defers to the Pantex Site-Wide EIS as the more accurate analysis of potential impacts from accidents.

F.2.1.1 *Accident Scenarios and Source Terms*

A range of hazardous conditions and potential accidents were reviewed as candidates for estimating the risks to workers and the public from operating this facility. Through a screening process, several evaluation basis and beyond evaluation basis accidents were selected for further definition and analysis. A brief description of each of the six accident scenarios and source terms is presented below. Table F.2.1.1–1 presents a summary of each accident scenario and source term. Further detail can be found in a topical report (HNUS 1996a).

Scenario 1: Aircraft impact and

Pantex Plant. Pantex is locate 13.6 km (8.5 mi) from the nort runway at Amarillo Internation scenario involving aircraft impact c into a cell or bay, possibly causing quent detonation of high explosive plutonium, or pit damage from debr of the probability of aircraft impact tures has been prepared for the *Dr Impact Statement for the Continue Pantex Plant and Associated St Weapons Components* (DOE/EI 1996). Based on existing informati into an assembly cell or bay buildin of hazardous material is consider extremely unlikely event with an e ity in the range of $1x10^{-7}$ to $5x10^{-6}$/ purposes a value of $8x10^{-7}$/yr high-speed military aircraft or a l aircraft crashing into a single facilit

TABLE F.2.1.1–1.—*Accident Scenarios for Downsized Weapons Assembly/Disassem*

Accident Scenario	Site	Accident Frequency (Per Year)	Total Mater Envi
1. Aircraft impact and release	Pantex	$8x10^{-7}$	[a]
	NTS	$<1x10^{-7}$	Not applicat
2. Explosive dispersal of plutonium from high explosives detonation in cell or bay	Pantex	$5.7x10^{-6}$	62 g to 5,00 metal
	NTS	$5.7x10^{-6}$	96 g to 5,00 metal
3. Mechanical release due to pit drop or impact of forklift breaching pit cladding	Pantex	$7.8x10^{-3}$	$6x10^{-5}$ g plu
	NTS	$7.8x10^{-3}$	$6x10^{-5}$ g plu
4. Inadvertent activation of explosive squib on tritium reservoir	Pantex	0.02	1.8 g of triti 18.2 g of e
	NTS	0.02	1.8 g of triti 18.2 g of e
5. Operational fire-induced plutonium release	Pantex	$1x10^{-5}$	20 g plutoni
	NTS	$1x10^{-5}$	20 g plutoni
6. Fire-induced release from tritium reservoirs in staging vault	Pantex	$4x10^{-7}$	600 g tritiur
	NTS	$4x10^{-7}$	600 g tritiur

[a] For the aircraft crash accident, the Stockpile Stewardship and Management PEIS impacts are based on a perce described in the Pantex Site-Wide Draft EIS. See the discussion under Scenario 1 in this section for additio
[b] The maximum amount of material is a hypothetical amount chosen for the purposes of this analysis.
Source: HNUS 1996a.

ficient damage to release plutonium. The degree of damage incurred and any subsequent release of radioactive materials depends on the size and speed of the aircraft involved, among other factors. The impacts of an aircraft crash into a stockpile stewardship and management weapons A/D Facility are based on an analysis performed for the Pantex Site-Wide EIS of an aircraft crash into Zone 4 and Zone 12 facilities. Since stockpile stewardship and management facilities are only in Zone 12, the Pantex Site-Wide EIS impacts were scaled to 28 percent of the public risk, and 61 percent of the maximum offsite individual risk. For the noninvolved worker, the Pantex Site-Wide EIS estimates that a worker at 100 m (328 ft) will not survive the aircraft crash effects. For the Stockpile Stewardship and Management PEIS, the noninvolved worker is assumed to be at 1,000 m (3,281 ft) and survives the crash. The accident consequences and risks to the noninvolved worker and the maximally exposed individual are discussed in section F.2.1.2.

Nevada Test Site. The probability of an aircraft impact into the downsized weapons A/D facilities is estimated at less than 10^{-7}/yr and, in accordance with NEPA guidelines, does not have to be considered further.

Scenario 2: Explosive dispersal of plutonium from HE detonation in cell or bay. The combined probability of an explosive dispersal of plutonium in a bay ($7x10^{-7}$/yr) or cell ($5x10^{-6}$/yr) is $5.7x10^{-6}$/yr. This value is conservatively based on 2,000 weapons operations per year. The anticipated number of weapons operations per year is 300 for the downsize A/D mission at Pantex.

Scenario 2.1: Explosive dispersal of plutonium from high explosives detonation in an assembly bay. Explosive dispersal of a plutonium pit would be the greatest when HE is in direct contact with the pit during an explosion or fire. The explosion would blow off the roof and doors of the bay; thus, no material would be retained inside the structure. As a result, it is assumed that all of the respirable plutonium would be released into the environment.

Pantex Plant. For the purposes of this analysis, the release of respirable plutonium from a Pantex assembly bay is assumed to be 5,000 grams (g) (176 ounces [oz]). The probability of this accident is $7x10^{-7}$/yr.

Nevada Test Site. For the purposes of this analysis, the release of respirable plutonium from a Nevada Test Site (NTS) assembly bay is assumed to be 5,000 g (176 oz). The probability of this accident is $7x10^{-7}$/yr.

Scenario 2.2: Explosive dispersal of plutonium from high explosives detonation in an assembly cell assuming no roof collapse. A detonation of 13.6 kilograms (kg) (30 pounds [lb]) (39 lb trinitrotoluene [TNT] equivalent) of HE is estimated to be the maximum amount of HE that would not cause the roof of a gravel gertie cell at Pantex or NTS to at least partially collapse. The explosion, which would cause greater than atmospheric pressures, would exist in the cell for approximately 1 minute. Since the roof does not collapse, a large fraction of the plutonium would be retained by the intact structures. In the case of large detonations causing the cell roof to collapse, the estimated release and consequences are bounded by the case in which the roof does not collapse.

Pantex Plant. The calculated respirable release from a Pantex assembly cell for this scenario is estimated to be 62 g (2.2 oz) of plutonium. The probability of this accident is $5x10^{-6}$/yr.

Nevada Test Site. The total respirable release from the NTS assembly cell for this scenario is estimated to be 96 g (3.4 oz) of plutonium. The probability of this accident is $5x10^{-6}$/yr.

Scenario 3: Mechanical release due to dropping a pit and breaching the cladding. For the purposes of this analysis, a pit is generically defined as a 6.5-kg (14-lb) spherical shell clad in thin metal alloy. Operational scenarios that have the potential to release small quantities of plutonium include dropping a pit onto the floor, cracking the external cladding because of disassembly stress, hitting a pit with other equipment, pulling out a pit tube during A/D, and breaching a container and pit with a forklift. A pit drop accident is used to characterize the category of events leading to violation of pit integrity.

An event of this nature has occurred at Pantex, where a weapon cladding was cracked, resulting in localized contamination around the pit. In this instance, the airborne contamination was insufficient to actuate the radiation alarm, and the worker dose was less than 0.1 rem.

Pantex Plant. The probability of a pit drop or forklift impact accident with a small plutonium release to a cell or bay at Pantex is 7.8×10^{-3}/yr. The total release to the environment is estimated to be 6×10^{-5} g of plutonium.

Nevada Test Site. The probability of a pit drop or forklift impact accident with a small plutonium release to a cell or bay at NTS is 7.8×10^{-3}/yr. The total release to the environment is estimated to be 6×10^{-5} g of plutonium.

Scenario 4: Inadvertent activation of explosive squib on tritium reservoir. During assembly or disassembly of a nuclear explosive, conditions could be encountered in which an electro-explosive device is accidentally fired and releases tritium from a reservoir. There have been two events (one at a weapons complex and one at a military installation) in which a squib was inadvertently actuated, releasing tritium from a reservoir. Since the events occurred, added precautions have been implemented. For this scenario, the squib valve must fire, releasing tritium from the reservoir, and the stem tube must be breached or disconnected from the pit (the latter is a normal step of disassembly).

For the purposes of this analysis, a reservoir is assumed to contain 20 g (0.7 oz) of elemental tritium. The entire amount of this tritium is assumed to be released in gaseous form. (Only hydrogen tritide is considered in assessing of worker dose, because only about 1 percent of hydrogen tritide is converted to tritium oxide after 1 hour.) All elemental tritium is 100 percent respirable. The amount of tritium which becomes airborne in the cell or bay is thus 20 g (0.7 oz). Upon detecting tritium, the exhaust fans will continue to operate and exhaust tritium to the atmosphere. The potential offsite doses from the tritium release would depend on the extent of tritium oxidation, which is estimated to be 9 percent as a bounding limit.

Pantex Plant. The probability of inadvertent squib activation during operations in an assembly cell or bay is 0.02/yr. The total release is estimated to be 1.8 g (0.06 oz) of tritium oxide and 18.2 g (0.6 oz) of elemental tritium.

Nevada Test Site. The probability of inadvertent squib activation during operations in an assembly cell or bay is estimated to be the same as at Pantex with the same total release of 1.8 g (0.06 oz) of tritium oxide and 18.2 g (0.6 oz) of elemental tritium.

Scenario 5: Operational fire-induced plutonium dispersal. The metal-clad plutonium pits are designed to maintain their integrity for certain temperature levels but are not intended to function as barriers against release. The facilities (assembly cells or bays) that can have plutonium pits outside of their containers would likely remain intact in a fire not associated with an explosion. A bounding scenario for fire-induced plutonium dispersal assumes the radioactive material limit in a cell or bay is dispersed by fire with no containment.

Pantex Site. The probability of an operational fire-induced plutonium dispersal is 1×10^{-5}/yr. The total material released is 20 g (0.7 oz) of plutonium oxide.

Nevada Test Site. The operational fire at Pantex is assumed to occur at NTS with the same frequency and release as at Pantex.

Scenario 6: Fire-induced release from tritium reservoirs in staging vault. In this scenario, an earthquake is assumed to cause a fire in the vault where in-process tritium reservoirs are stored. The fire causes 100 percent of the tritium reservoirs in the vault to fail, releasing its entire contents. In addition, it is assumed that the elemental tritium is completely oxidized by the fire.

Pantex Plant. The probability of a release of tritium from the Pantex A/D staging area is 4×10^{-7}/yr. For the purposes of this analysis, the release is assumed to be 600 g (21 oz) of tritium oxide.

Nevada Test Site. It is assumed that this scenario at Pantex would be applicable at NTS. Therefore, the accident probability is 4×10^{-7}/yr. For the purposes of

ıe release is assumed to be 600 g
ı oxide.

nt Consequences and Risk

–1 and F.2.1.2–2 list the set of
ed to represent consequences and
s and the public from accidental
active materials during operations at
, respectively. For each accident, the
he frequency of occurrence and the
:o a hypothetical worker located
ft) from the accident, a hypothetical
ɜd at the nearest site boundary, and
› a distance of 80 km (50 mi). The
atality for the worker, the individual
ary, and the public for the composite
ıre also shown.

ıry and Case Fabrication

s accidents and beyond evaluation
ıave been studied for the secondary
tion operations. The studies postu-
ident scenarios that were representa-
ınd consequences for workers and the
n be expected from operations.
potential accidents were addressed,
postulated have consequences and
pected to envelop the consequences
:elocated operations.

ɪnt Scenarios and Source Terms

ɜardous conditions and potential
reviewed as candidates to represent
acility's operation to workers and the
ı a screening process, several evalua-
lents and beyond evaluation basis
selected for further definition and
ief description of each of the 12
ɪios and source terms is presented
2.2.1–1 presents a summary of each
› and source term. Further detail can
›ical report (HNUS 1996a).

Nuclear criticality. Criticality
stulated at nearly all locations where
uranium (HEU) is handled. Potential
: operator error and loss of safe
ing from fire damage to aluminum birdcage containers or structural damage from an earthquake. Both ground-level and elevated fission product releases to the atmosphere are postulated. The postulated criticality is based on the characteristics of a solution as specified by the U.S. Nuclear Regulatory Commission.

For the accidental criticality evaluated, it is assumed that $1x10^{19}$ fissions occur before reaching a stable, subcritical condition. This total is comprised of an initial burst of $1x10^{18}$ fissions followed by repeated bursts of $1x10^{17}$ fissions over an 8-hour period as liquid is assumed to be boiled from a solution system. 100 percent of the xenon and krypton formed is released; 25 percent of the iodine is released.

Oak Ridge Reservation. The criticality accident frequency is assumed to be extremely unlikely ($1x10^{-6}$ to $1x10^{-4}$/yr).

Los Alamos National Laboratory. The criticality accident frequency is assumed to be extremely unlikely ($1x10^{-6}$ to $1x10^{-4}$/yr).

Lawrence Livermore National Laboratory. The criticality accident frequency is assumed to be extremely unlikely ($1x10^{-6}$ to $1x10^{-4}$/yr).

Scenario 2: Fire-induced dispersion of highly enriched uranium from a building collapse and resultant fire. The postulated accident assumes that a beyond evaluation basis earthquake causes the uranium process, component fabrication, and storage facilities to collapse. Ruptured gas lines and/or hydraulic lines cause fires in the process and component fabrication facilities.

Oak Ridge Reservation. The frequency of this accident is beyond evaluation basis ($1x10^{-7}$ to $1x10^{-6}$). The total HEU source term released in oxide form is estimated to be 17 kg (37 lb) and 1.5 kg (3.3 lb) of depleted uranium.

Los Alamos National Laboratory. The accident defined for Oak Ridge Reservation (ORR) is assumed to be valid at Los Alamos National Laboratory (LANL). The frequency is assumed to be in the range of $1x10^{-7}$ to $1x10^{-6}$/yr. The total release is 17 kg (37 lb) of HEU and 1.5 kg (3.3 lb) of depleted uranium. The location of the release is the Chemistry and Metallurgy Research Building.

TABLE F.2.1.2–1.—*Downsized Weapons Assembly/Disassembly Operations at Pantex Plant, Impacts of Accidents*

Accident Scenario	Noninvolved Worker at 1,000 Meters		Maximum Offsite Individual		Population to 80 Kilometers		
	Dose (rem)	Probability of Cancer Fatality[a]	Dose (rem)	Probability of Cancer Fatality[a]	Dose (person-rem)	Cancer Fatalities	Accident Frequency (per year)
1. Aircraft impact and release[b]	23	9.2×10^{-3}	23	0.012	2.8×10^{3}	1.4	8.0×10^{-7}
2. Explosive dispersal of plutonium in cell or bay	16.9	6.8×10^{-3}	12.9	6.5×10^{-3}	3.8×10^{3}	1.9	5.7×10^{-6}
3. Mechanical release from impact breach of pit cladding	3.2×10^{-6}	1.3×10^{-9}	2.4×10^{-6}	1.2×10^{-9}	6.5×10^{-4}	3.2×10^{-7}	7.8×10^{-3}
4. Inadvertent activation of explosive squib on tritium reservoir	9.7×10^{-4}	3.9×10^{-7}	7.4×10^{-4}	3.7×10^{-7}	0.20	9.9×10^{-5}	0.02
5. Operational fire-induced plutonium release	0.52	2.1×10^{-4}	0.40	2.0×10^{-4}	107	0.054	1.0×10^{-5}
6. Fire-induced release from tritium reservoirs in staging vault[b]	0.31	1.2×10^{-4}	0.24	1.2×10^{-4}	66	0.033	4.0×10^{-7}
Impacts for Composite Set of EBAs and BEBAs[c]							
Expected consequences[d]		2.0×10^{-6}		2.0×10^{-6}		5.2×10^{-4}	
Expected risk (per year)		5.6×10^{-8}		5.6×10^{-8}		1.5×10^{-5}	
Impacts for Composite Set of EBAs							
Expected consequences[d]		1.7×10^{-6}		1.7×10^{-6}		4.8×10^{-4}	
Expected risk (per year)		4.8×10^{-8}		4.6×10^{-8}		1.3×10^{-5}	
Impacts for Composite Set of BEBAs							
Expected consequences[d]		6.2×10^{-3}		8.0×10^{-3}		0.94	
Expected risk (per year)		7.4×10^{-9}		9.7×10^{-9}		1.1×10^{-6}	

[a] Probability (increased likelihood) of cancer fatality to a hypothetical member of the public located at the site boundary or a worker located at 1,000 m (3,281 ft) from the accident as a result of exposure to the indicated dose if the accident occurred.

[b] A beyond evaluation basis accident (BEBA). All other listed accidents are evaluation basis accidents (EBA).

[c] For the offsite population of 285,409, the average probability of cancer fatality/risk of cancer fatality (per year) for the composite set of accidents is $1.8\times10^{-9}/5.3\times10^{-11}$.

[d] Result of exposure to the indicated dose if the accident occurs.

Note: All values are mean values.

Source: Model results.

TABLE F.2.1.2–2.—*Downsized Weapons Assembly/Disassembly Operations at Nevada Test Site, Impacts of Accidents*

Accident Scenario	Noninvolved Worker at 1,000 Meters		Maximum Offsite Individual		Population to 80 Kilometers		
	Dose (rem)	Probability of Cancer Fatality[a]	Dose (rem)	Probability of Cancer Fatality[a]	Dose (person-rem)	Cancer Fatalities	Accident Frequency (per year)
1. Aircraft impact and release	[b]	[b]	[b]	[b]	[b]	[b]	[b]
2. Explosive dispersal of plutonium in cell or bay	26.1	0.01	2.3	1.1×10^{-3}	361	0.18	5.7×10^{-6}
3. Mechanical release from impact breach of pit cladding	4.7×10^{-6}	1.9×10^{-9}	4.0×10^{-7}	2.0×10^{-10}	5.4×10^{-5}	2.7×10^{-8}	7.8×10^{-3}
4. Inadvertent activation of explosive squib on tritium reservoir	1.4×10^{-3}	5.7×10^{-7}	1.2×10^{-4}	6.2×10^{-8}	0.016	8.1×10^{-6}	0.02
5. Operational fire-induced plutonium release	0.77	3.1×10^{-4}	0.066	3.3×10^{-5}	8.9	4.4×10^{-3}	1.0×10^{-5}
6. Fire-induced release from tritium reservoirs in staging vault[c]	0.42	1.7×10^{-4}	0.038	1.9×10^{-5}	5.6	2.8×10^{-3}	4.0×10^{-7}
Impacts of Composite Set of EBAs and BEBAs[d]							
Expected consequences[e]		2.7×10^{-6}		2.9×10^{-7}		4.4×10^{-5}	
Expected risk (per year)		7.4×10^{-8}		8.1×10^{-9}		1.2×10^{-6}	
Impacts for Composite Set of EBAs							
Expected consequences[e]		2.7×10^{-6}		2.9×10^{-7}		4.4×10^{-5}	
Expected risk (per year)		7.4×10^{-8}		8.1×10^{-9}		1.2×10^{-6}	
Impacts for Composite Set of BEBAs							
Expected consequences[e]		1.7×10^{-4}		1.9×10^{-5}		2.8×10^{-3}	
Expected risk (per year)		6.7×10^{-11}		7.7×10^{-12}		1.1×10^{-9}	

[a] Probability (increased likelihood) of cancer fatality to a hypothetical member of the public located at the site boundary or to a worker located 1,000 m (3,281 ft) from the accident as a result of exposure to the indicated dose if the accident occurred.

[b] Not applicable. The probability of an aircraft crash is estimated to be lower than 10^{-7}/yr.

[c] A beyond evaluation basis accident (BEBA). All other listed accidents are evaluation basis accidents (EBA).

[d] For the offsite population of 18,517, the average probability of cancer fatality/risk of cancer fatality (per year) for the composite set of accidents is $2.4 \times 10^{-9}/6.5 \times 10^{-11}$.

[e] Result of exposure to the indicated dose if the accident occurs.

Note: All values are mean values.

Source: Model results.

TABLE F.2.2.1–1.—*Accident Scenarios for Secondary and Case Fabricati*

Accident Scenario	Site	Accident Frequency (per year)	Total Material Enviror
1. Nuclear criticality	ORR	$1x10^{-6}$ to $1x10^{-4}$	$1x10^{19}$ fissions
	LANL	$1x10^{-6}$ to $1x10^{-4}$	$1x10^{19}$ fissions
	LLNL	$1x10^{-6}$ to $1x10^{-4}$	$1x10^{19}$ fissions
2. Fire-induced dispersion of highly enriched uranium from a building collapse and resultant fire	ORR	$1x10^{-7}$ to $1x10^{-6}$	17 kg of HEU an depleted uraniu
	LANL	$1x10^{-7}$ to $1x10^{-6}$	17 kg of HEU an depleted uraniu
	LLNL	$1x10^{-7}$ to $1x10^{-6}$	17 kg of HEU anc depleted uraniur
3. Dry criticality resulting from vehicle accident	ORR	$1x10^{-6}$ to $1x10^{-4}$	$1x10^{18}$ fissions
	LANL	$1x10^{-6}$ to $1x10^{-4}$	$1x10^{18}$ fissions
	LLNL	$1x10^{-6}$ to $1x10^{-4}$	$1x10^{18}$ fissions
4. Fire-induced release of highly enriched uranium from solvent fire	ORR	$1x10^{-6}$ to $1x10^{-4}$	4 kg of HEU
	LANL	$1x10^{-6}$ to $1x10^{-4}$	4 kg of HEU
	LLNL	$1x10^{-6}$ to $1x10^{-4}$	4 kg of HEU
5. Fire-induced release of highly enriched uranium from metallurgical operations	ORR	$1x10^{-6}$ to $1x10^{-4}$	3.75 kg of HEU
	LANL	$1x10^{-6}$ to $1x10^{-4}$	3.75 kg of HEU
	LLNL	$1x10^{-6}$ to $1x10^{-4}$	3.75 kg of HEU
6. Fire-induced release of lithium	ORR	$1x10^{-6}$ to $1x10^{-4}$	2,800 kg Li_2O
	LANL	$1x10^{-6}$ to $1x10^{-4}$	2,800 kg Li_2O
	LLNL	$1x10^{-6}$ to $1x10^{-4}$	2,800 kg Li_2O
7. Fire-induced release of highly enriched uranium on loading dock	ORR	$1x10^{-6}$ to $1x10^{-4}$	0.8 kg of HEU
	LANL	$1x10^{-6}$ to $1x10^{-4}$	0.8 kg of HEU
	LLNL	$1x10^{-6}$ to $1x10^{-4}$	0.8 kg of HEU
8. Filter failure-induced release of highly enriched uranium	ORR	$1x10^{-6}$ to $1x10^{-4}$	1.6 kg of HEU
	LANL	$1x10^{-6}$ to $1x10^{-4}$	1.6 kg of HEU
	LLNL	$1x10^{-6}$ to $1x10^{-4}$	1.6 kg of HEU
9. Mechanical release of hydrogen fluoride	ORR	$1x10^{-6}$ to $1x10^{-4}$	386 kg of hydrogen
	LANL	$1x10^{-6}$ to $1x10^{-4}$	386 kg of hydrogen
	LLNL	$1x10^{-6}$ to $1x10^{-4}$	386 kg of hydrogen
10. Fire-induced release of hydrogen cyanide	ORR	$1x10^{-6}$ to $1x10^{-4}$	300 kg of acetonitril
	LANL	$1x10^{-6}$ to $1x10^{-4}$	300 kg of acetonitril
	LLNL	$1x10^{-6}$ to $1x10^{-4}$	300 kg of acetonitril

Source: HNUS 1996a.

Lawrence Livermore National Laboratory. The accident defined for ORR is assumed to be valid at Lawrence Livermore National Laboratory (LLNL). The frequency is assumed to be in the range of $1x10^{-7}$ to $1x10^{-6}$/yr. The total release is 17 kg (37 lb) of HEU and 1.5 kg (3.3 lb) of depleted uranium.

Scenario 3: Dry criticality resulting from vehicle accident. A vehicle accident is postulated in which the contents are dislodged and possibly moderating materials, creating a critic oxide powder is spilled and collected in low point. The accidental criticali initiated by an error in strapping or by w off a bottle dolly. The postulated critical $1x10^{18}$ fissions for the dry criticality.

Oak Ridge Reservation. The accident frequency is assumed to be in the range of extremely unlikely ($1x10^{-6}$ to $1x10^{-4}$/yr).

Los Alamos National Laboratory. The accident is assumed to occur at LANL with a frequency of $1x10^{-6}$ to $1x10^{-4}$/yr.

Lawrence Livermore National Laboratory. The accident is assumed to occur at LLNL with a frequency of $1x10^{-6}$ to $1x10^{-4}$/yr.

Scenario 4: Fire-induced release of highly enriched uranium from a solvent fire. A fire releasing uranium aerosols is postulated to occur. The types of fires include contaminated trash, solvents containing uranium solutions, uranium chips, and larger uranium metal shapes. A solvent fire releasing uranium-laden combustion gases at ground level is assumed. In this scenario, the entire contents of an extraction column would be released via a pipe break or other failure and are ignited by an electrical fault. Complete combustion would occur.

Oak Ridge Reservation. The release at ORR is estimated to be 4 kg (8.8 lb) of HEU with a frequency in the range of $1x10^{-6}$ to $1x10^{-4}$/yr.

Los Alamos National Laboratory. The accident is assumed to occur at LANL with a frequency in the range of $1x10^{-6}$ to $1x10^{-4}$/yr and a release of 4 kg (8.8 lb) of HEU.

Lawrence Livermore National Laboratory. The accident is assumed to occur at LLNL with a frequency in the range of $1x10^{-6}$ to $1x10^{-4}$/yr and a release of 4 kg (8.8 lb) of HEU.

Scenario 5: Fire-induced release of highly enriched uranium. A uranium fire accident is postulated to occur during metallurgical operations when a 4-liter (L) (1-gallon [gal]) container of briquettes ignites while check weighing before being loaded into a crucible. The total material at risk is estimated to be 15 kg (33 lb) of HEU.

Oak Ridge Reservation. The accident is assumed to occur with a frequency in the range of $1x10^{-6}$ to $1x10^{-4}$ /yr and a release of 3.75 kg (8.31 lb) of HEU.

Los Alamos National Laboratory. The accident is assumed to occur with a frequency in the range of $1x10^{-6}$ to $1x10^{-4}$ /yr and a release of 3.75 kg (8.3 lb) of HEU.

Lawrence Livermore National Laboratory. The accident is assumed to occur with a frequency in the range of $1x10^{-6}$ to $1x10^{-4}$/yr and a release of 3.75 kg (8.31 lb) of HEU.

Scenario 6: Fire-induced release of lithium. A lithium fire is postulated to occur when burning lithium produces hazardous lithium oxide.

Oak Ridge Reservation. The probability of the accident is assumed to be in the range of $1x10^{-6}$ to $1x10^{-4}$/yr and to release 2,800 kg (6,170 lb) of lithium oxide.

Los Alamos National Laboratory. The probability of the accident is assumed to be in the range of $1x10^{-6}$ to $1x10^{-4}$/yr and to release 2,800 kg (6,170 lb) of lithium oxide.

Lawrence Livermore National Laboratory. The probability of the accident is assumed to be in the range of $1x10^{-6}$ to $1x10^{-4}$/yr and to the release 2,800 kg (6,170 lb) of lithium oxide.

Scenario 7: Fire-induced release of highly enriched uranium on loading dock. A uranium metal fire at the loading dock is postulated to occur and results in a release of heated uranium aerosols at ground level. The fire is assumed to burn for 30 minutes and, during that time, completely oxidate the uranium metal in the transport vehicle. The effective release height is estimated to be 30 m (98 ft) because of thermal buoyancy.

Oak Ridge Reservation. The amount of HEU released to the atmosphere is 0.8 kg (1.8 lb) with an assumed frequency in the range of $1x10^{-6}$ to $1x10^{-4}$/yr.

Los Alamos National Laboratory. The accident is assumed to occur at LANL with a frequency in the range of $1x10^{-6}$ to $1x10^{-4}$/yr. The release is estimated to be 0.8 kg (1.8 lb) of HEU with a release height of 30 m (98 ft).

Lawrence Livermore National Laboratory. The accident is assumed to occur at LLNL with a frequency in the range of $1x10^{-6}$ to $1x10^{-4}$/yr. The release is estimated to be 0.8 kg (1.8 lb) of HEU with a release height of 30 m (98 ft).

Scenario 8: Filter failure release of highly enriched uranium. Mechanical upsets are events such as spills, forklift punctures, loss of filtration, and piping failures. The mechanical upset would result in small releases to the atmosphere, unless the off-gas filters in the fluid bed system fail. The bounding accident scenario postulates that both the primary and secondary filters rupture internally, allowing the contained charge of uranium oxide and uranium fluoride particles to be released to the atmosphere via the exhaust stack.

Oak Ridge Reservation. The release to the atmosphere is 1.6 kg (3.5 lb) of HEU from the filter. The assumed accident frequency is in the range of $1x10^{-6}$ to $1x10^{-4}$/yr.

Los Alamos National Laboratory. The release to the atmosphere is 1.6 kg (3.5 lb) of HEU from the filter. The assumed accident frequency is in the range of $1x10^{-6}$ to $1x10^{-4}$/yr.

Lawrence Livermore National Laboratory. The release to the atmosphere is 1.6 kg (3.5 lb) of HEU from the filter. The assumed accident frequency is in the range of $1x10^{-6}$ to $1x10^{-4}$/yr.

Scenario 9: Mechanical release of hydrogen fluoride. This accident is postulated as a large spill of hydrogen fluoride that would generate a dense cloud of hydrogen fluoride that can exceed Level of Concern limits. It is assumed that the entire contents of a tank containing 386 kg (850 lb) of hydrogen fluoride would leak from a 2.54-centimeter (cm) (1-inch [in]) hole, emptying the tank in 12 minutes.

Oak Ridge Reservation. The accident frequency is assumed to range from $1x10^{-6}$ to $1x10^{-4}$/yr. The release is the tank's entire contents of 386 kg (850 lb) of hydrogen fluoride.

Los Alamos National Laboratory. The accident frequency is assumed to range from $1x10^{-6}$ to $1x10^{-4}$/yr. The release is the tank's entire contents of 386 kg (850 lb) of hydrogen fluoride.

Lawrence Livermore National Labora
accident frequency is assumed to range fro
$1x10^{-4}$/yr. The release is the tank's entire
386 kg (850 lb) of hydrogen fluoride.

Scenario 10: Fire-induced release of cyanide during a vehicle impact. A vehi
accident is postulated to occur and cause a
one or more drums containing acetonitr
waste. The spill is ignited by a spark, and th
fire spreads to other drums in the area
produces hydrogen cyanide.

Oak Ridge Reservation. The accident fr
assumed to be in the range of $1x10^{-6}$ to 1x1
release involves 300 kg (660 lb) of solvent v

Los Alamos National Laboratory. The
frequency is assumed to be in the range o
$1x10^{-4}$/yr. The release involves 300 kg (
solvent waste.

Lawrence Livermore National Laborat
accident frequency is assumed to be in th
$1x10^{-6}$ to $1x10^{-4}$/yr. The release involv
(660 lb) of solvent waste.

F.2.2.2 *Accident Consequences and Risk*

Tables F.2.2.2–1, F.2.2.2–2, and F.2.2.2–3 lis
accidents selected to represent consequence
to workers and the public from accidental
radioactive materials during operations
LANL, and LLNL, respectively. For each
the table identifies the frequency of occurren
consequences to a hypothetical worker at a
distance from the accident, a hypothetical
located at the nearest site boundary, and the
to a distance of 80 km (50 mi). The risks
fatality for the worker, the individual a
boundary, and the public for the compos
accidents are also shown.

F.2.3 Pit Fabrication and Intrusive Mo Pit Reuse

Studies of evaluation basis accidents and bey
ation basis accidents have been performed
fabrication and intrusive modification pit re
tions. The studies postulated a set of acciden
that were representative of the risks and con

TABLE F.2.2.2–1.—*Secondary and Case Fabrication at Oak Ridge Reservation, Impacts of Accidents*

Accident Scenario	Noninvolved Worker at 619 Meters		Maximum Offsite Individual		Population to 80 Kilometers		
	Dose (rem)	Probability of Cancer Fatality[a]	Dose (rem)	Probability of Cancer Fatality[a]	Dose (person-rem)	Cancer Fatalities	Accident Frequency (per year)
1. Nuclear criticality	0.051	2.0×10^{-5}	0.051	2.5×10^{-5}	3.1	1.5×10^{-3}	1.0×10^{-5}
2. Fire-induced dispersion of highly enriched uranium from a building collapse and resultant fires[b]	2.4	9.6×10^{-4}	2.4	1.2×10^{-3}	363	0.18	5.0×10^{-7}
3. Dry criticality resulting from vehicle accident	5.1×10^{-3}	2.0×10^{-6}	5.1×10^{-3}	2.5×10^{-6}	0.31	1.5×10^{-4}	1.0×10^{-5}
4. Fire-induced release of highly enriched uranium from solvent fire	0.57	2.3×10^{-4}	0.57	2.9×10^{-4}	86	0.04	1.0×10^{-5}
5. Fire-induced release of highly enriched uranium from metallurgical operations	0.54	2.2×10^{-4}	0.54	2.7×10^{-4}	80.6	0.04	1.0×10^{-5}
7. Fire-induced release of highly enriched uranium on loading dock	0.083	3.3×10^{-5}	0.083	4.2×10^{-5}	17.6	8.8×10^{-3}	1.0×10^{-5}
8. Filter failure-induced release of highly enriched uranium	0.23	9.2×10^{-5}	0.23	1.1×10^{-4}	34.3	0.017	1.0×10^{-5}
Impacts for Composite Set of EBAs and BEBAs[c]							
Expected consequences[d]		1.1×10^{-4}		1.3×10^{-4}		0.02	
Expected risk (per year)		6.4×10^{-9}		8.0×10^{-9}		1.2×10^{-6}	
Impacts for Composite Set of EBAs							
Expected consequences[d]		1.0×10^{-4}		1.2×10^{-4}		0.018	
Expected risk (per year)		5.9×10^{-9}		7.4×10^{-9}		1.1×10^{-6}	
Impacts for Composite Set of BEBAs							
Expected consequences[d]		9.7×10^{-4}		1.2×10^{-3}		0.18	
Expected risk (per year)		4.9×10^{-10}		6.0×10^{-10}		9.1×10^{-8}	

[a] Probability (increased likelihood) of cancer fatality to a hypothetical member of the public located at the site boundary or a worker located at the indicated distance from the accident as a result of exposure to the indicated dose if the accident were to occur.

[b] A beyond evaluation basis accident (BEBA). All other listed accidents are evaluation basis accidents (EBA).

[c] For the offsite population of 1,096,144, the average probability of cancer fatality/risk of cancer fatality (per year) for the composite set of accidents is $1.8\times10^{-8}/1.1\times10^{-12}$.

[d] Result of exposure to the indicated dose if the accident occurs.

Note: All values are mean values.

Source: Model results.

TABLE F.2.2.2–2.—*Secondary and Case Fabrication at Los Alamos National Laboratory, Impacts of Accidents*

Accident Scenario	Noninvolved Worker at 862 Meters		Maximum Offsite Individual		Population to 80 Kilometers		
	Dose (rem)	Probability of Cancer Fatality[a]	Dose (rem)	Probability of Cancer Fatality[a]	Dose (person-rem)	Cancer Fatalities	Accident Frequency (per year)
1. Nuclear criticality	0.034	1.4×10^{-5}	0.034	1.7×10^{-5}	4.9	2.4×10^{-3}	1.0×10^{-5}
2. Fire-induced dispersion of highly enriched uranium from a building collapse and resultant fire[b]	1.6	6.2×10^{-4}	1.6	7.7×10^{-4}	360	0.18	5.0×10^{-7}
3. Dry criticality resulting from vehicle accident	3.4×10^{-3}	1.4×10^{-6}	3.4×10^{-3}	1.7×10^{-6}	0.49	2.4×10^{-4}	1.0×10^{-5}
4. Fire-induced release of highly enriched uranium from solvent fire	0.36	1.5×10^{-4}	0.36	1.8×10^{-4}	84.5	0.042	1.0×10^{-5}
5. Fire-induced release of highly enriched uranium from metallurgical operations	0.34	1.4×10^{-4}	0.34	1.7×10^{-4}	79.4	0.04	1.0×10^{-5}
7. Fire-induced release of highly enriched uranium on loading dock	0.053	2.1×10^{-5}	0.053	2.6×10^{-5}	15.0	7.5×10^{-3}	1.0×10^{-5}
8. Filter failure-induced release of highly enriched uranium	0.15	5.8×10^{-5}	0.15	7.3×10^{-5}	33.8	0.017	1.0×10^{-5}
Impacts for Composite Set of EBAs and BEBAs[c]							
Expected consequences[d]		6.8×10^{-5}		8.4×10^{-5}		0.02	
Expected risk (per year)		4.1×10^{-9}		5.1×10^{-9}		1.2×10^{-6}	
Impacts for Composite Set of EBAs							
Expected consequences[d]		6.3×10^{-5}		7.9×10^{-5}		0.018	
Expected risk (per year)		3.8×10^{-9}		4.7×10^{-9}		1.1×10^{-6}	
Impacts for Composite Set of BEBAs							
Expected consequences[d]		6.2×10^{-4}		7.7×10^{-4}		0.18	
Expected risk (per year)		3.1×10^{-10}		3.9×10^{-10}		8.9×10^{-8}	

[a] Probability (increased likelihood) of cancer fatality to a hypothetical member of the public located at the site boundary or a worker located at the indicated distance from the accident as a result of exposure to the indicated dose if the accident occurred.

[b] A beyond evaluation basis accident (BEBA). All other listed accidents are evaluation basis accidents (EBA).

[c] For the offsite population of 281,812, the average probability of cancer fatality/risk of cancer fatality (per year) for the composite set of accidents is $7.1\times10^{-8}/4.3\times10^{-12}$.

[d] Result of exposure to the indicated dose if the accident occurs.

Note: All values are mean values.

TABLE F.2.2.2–3.—*Secondary and Case Fabrication at Lawrence Livermore National Laboratory, Impacts of Accidents*

Accident Scenario	Noninvolved Worker at 247 Meters		Maximum Offsite Individual		Population to 80 Kilometers		
	Dose (rem)	Probability of Cancer Fatality[a]	Dose (rem)	Probability of Cancer Fatality[a]	Dose (person-rem)	Cancer Fatalities	Accident Frequency (per year)
1. Nuclear criticality	0.07	2.8×10^{-5}	0.07	3.5×10^{-5}	9.9	5.0×10^{-3}	1.0×10^{-5}
2. Fire-induced dispersion of highly enriched uranium from a building collapse and resultant fire[b]	3.4	1.4×10^{-3}	3.4	1.7×10^{-3}	1.2×10^{3}	0.58	5.0×10^{-7}
3. Dry criticality resulting from vehicle accident	7.0×10^{-3}	2.8×10^{-6}	7.0×10^{-3}	3.5×10^{-6}	0.99	5.0×10^{-4}	1.0×10^{-5}
4. Fire-induced release of highly enriched uranium from solvent fire	0.8	3.2×10^{-4}	0.80	4.0×10^{-4}	273	0.14	1.0×10^{-5}
5. Fire-induced release of highly enriched uranium from metallurgical operations	0.75	3.0×10^{-4}	0.75	3.8×10^{-4}	257	0.13	1.0×10^{-5}
7. Fire-induced release of highly enriched uranium on loading dock	0.11	4.2×10^{-5}	0.11	5.3×10^{-5}	53.2	0.027	1.0×10^{-5}
8. Filter failure-induced release of highly enriched uranium	0.32	1.3×10^{-4}	0.32	1.6×10^{-4}	109	0.055	1.0×10^{-5}
Impacts for Composite Set of EBAs and BEBAs[c]							
Expected consequences[d]		1.5×10^{-4}		1.8×10^{-4}		0.063	
Expected risk (per year)		8.9×10^{-9}		1.1×10^{-8}		3.8×10^{-6}	
Impacts for Composite Set of EBAs							
Expected consequences[d]		1.4×10^{-4}		1.7×10^{-4}		0.06	
Expected risk (per year)		8.2×10^{-9}		1.0×10^{-8}		3.5×10^{-6}	
Impacts for Composite Set of BEBAs							
Expected consequences[d]		1.4×10^{-3}		1.7×10^{-3}		0.6	
Expected risk (per year)		6.8×10^{-10}		8.5×10^{-10}		2.9×10^{-7}	

[a] Probability (increased likelihood) of cancer fatality to a hypothetical member of the public located at the site boundary or a worker located 247 m (810 ft) from the accident as a result of exposure to the indicated dose if the accident occurred.

[b] A beyond evaluation basis accident (BEBA). All other listed accidents are evaluation basis accidents (EBA).

[c] For the offsite population of 7,843,061, the average probability of cancer fatality/risk of cancer fatality (per year) for the composite set of accidents is $8.0\times10^{-9}/4.8\times10^{-13}$.

[d] Result of exposure to the indicated dose if the accident occurs.

Note: All values are mean values.

Source: Model results.

TABLE F.2.3.1–1.—*Accident Scenarios for Pit Fabrication and Intrusive Modific Pit Reuse*

Accident Scenario	Site	Accident Frequency (per year)	Total Material I Environn
1. Fire-induced release of plutonium from a glove box	LANL	$1x10^{-4}$ to 0.01	0.24 g plutonium
	SRS	$1x10^{-4}$ to 0.01	0.24 g plutonium
2. Operational release of tritium	LANL	$1x10^{-6}$ to $1x10^{-4}$	21,000 Ci of tritiu
	SRS	$1x10^{-6}$ to $1x10^{-4}$	21,000 Ci of tritiu
3. Mechanical release of nitric acid into confined area	LANL	$1x10^{-6}$ to $1x10^{-4}$	6,100 gal of 80-pe acid in bermed a
	SRS	$1x10^{-6}$ to $1x10^{-4}$	6,100 gal of 80-pe acid in bermed a
4. Earthquake-induced mechanical release of nitric acid	LANL	$1x10^{-7}$ to $1x10^{-6}$	6,100 gal of 80-pe acid in bermed a
	SRS	$1x10^{-7}$ to $1x10^{-6}$	6,100 gal of 80-pe acid in bermed a
5. Earthquake-induced release of plutonium	LANL	$1x10^{-6}$ to $1x10^{-4}$	0.61 g of plutoniun metal
	SRS	$1x10^{-6}$ to $1x10^{-4}$	0.61 g of plutoniun metal
6. Earthquake-induced release of plutonium	LANL	$1x10^{-7}$ to $1x10^{-6}$	0.63 g of plutoniun metal
	SRS	$1x10^{-7}$ to $1x10^{-6}$	0.63 g of plutonium metal
7. Wet criticality	LANL	$1x10^{-7}$ to $1x10^{-6}$	$5x10^{17}$ fissions
	SRS	$1x10^{-7}$ to $1x10^{-6}$	$5x10^{17}$ fissions
8. Mechanical-induced release of plutonium	LANL	0.01 to $1x10^{-1}$	$7.2x10^{-12}$ g of plutonium oxide
	SRS	0.01 to $1x10^{-1}$	$7.2x10^{-12}$ g of plutonium oxide
9. Explosive-induced release of plutonium	LANL	$1x10^{-4}$ to 0.01	0.05 g of plutonium metal
	SRS	$1x10^{-4}$ to 0.01	0.05 g of plutonium metal
10. Fire-induced release of plutonium on loading dock	LANL	$1x10^{-6}$ to $1x10^{-4}$	0.8 g plutonium oxid
	SRS	$1x10^{-6}$ to $1x10^{-4}$	0.8 g plutonium oxid

[a] The maximum amount of material is a hypothetical amount chosen for the purpose of this analysis.
Source: HNUS 1996a.

for workers and the public that can be expected from operations. Although not all potential accidents were addressed, those that were postulated have consequences and risks that are expected to envelop the consequences and risks of the relocated operations.

F.2.3.1 *Accident Scenarios and Source Terms*

A range of hazardous conditions and potential accidents were reviewed as candidates to represent the risks to workers and the public of the replacement pit fabrication and intrusive modification at Savannah River Site (SRS) and LAN tively. Through a screening process, seve tion basis accidents and beyond evalua accidents were selected for further defir analysis. Descriptive information on these is provided in table F.2.3.1–1.

Scenario 1: Fire-induced release of pl from a glove box. A fire is postulated with ratory which involves cleaning liquid such a

or isopropyl alcohol and burns the gloves in a glove box. The fire releases the plutonium contamination from the outer surface of the gloves that are in the glove box. Fire suppression and ventilation systems are assumed to be inoperable.

Los Alamos National Laboratory. The accident frequency is estimated to be in the range of $1x10^{-4}$ to 0.01/yr. The estimated release is 0.24 g ($8.47x10^{-3}$ oz) of plutonium oxide.

Savannah River Site. The accident frequency is estimated to be in the range of $1x10^{-4}$ to 0.01/yr. The estimated release is 0.24 g ($8.47x10^{-3}$ oz) of plutonium oxide.

Scenario 2: Operational release of tritium from special recovery line. This postulated accident is initiated by the loss of the inert atmosphere in the disassembly glove box in the special recovery line. As a result of the loss of inert atmosphere, a fire is assumed to start. As the tritium storage container is heated, tritium is released. It is assumed that released tritium bypasses the tritium collection system.

Los Alamos National Laboratory. The accident frequency is estimated to be in the range of $1x10^{-6}$ to $1x10^{-4}$/yr. For the purposes of this analysis, the release is assumed to be 21,000 curies (Ci) of tritium oxide.

Savannah River Site. The accident is assumed to be applicable at SRS with an estimated frequency in the range of $1x10^{-6}$ to $1x10^{-4}$/yr. For the purposes of this analysis, the release is assumed to be 21,000 Ci of tritium oxide.

Scenario 3. Mechanical release of nitric acid into confined bermed area. A mechanical failure in a tank, valve, or piping is postulated that releases the entire contents of an 80-percent nitric acid storage tank. The tank is located outdoors within a bermed area. The inventory is confined to the berm surrounding the tank.

Los Alamos National Laboratory. The nitric acid tank contains 23,090 L (6,100 gal) of 80-percent nitric acid. The bermed area is 27 square meters (m^2) (288 square feet [ft^2]). The accident frequency is estimated to be in the range of $1x10^{-6}$ to $1x10^{-4}$/yr.

Savannah River Site. The same nitric acid tank and bermed area are assumed to located at SRS. The tank contains 23,090 L (6,100 gal) of 80-percent nitric acid. The bermed area is 27 m^2 (288 ft^2). The accident frequency is estimated to be in the range of $1x10^{-6}$ to $1x10^{-4}$/yr.

Scenario 4: Beyond evaluation basis earthquake-induced release of nitric acid. A mechanical failure in a tank, valve, or piping is postulated that releases the entire contents of an 80-percent nitric acid storage tank. The tank is located outdoors within a bermed area; however, a beyond evaluation basis earthquake ruptures the berm. The inventory is not confined to the berm surrounding the tank.

Los Alamos National Laboratory. The nitric acid tank contains 23,090 L (6,100 gal) of 80-percent nitric acid. The accident frequency is estimated to be in the range of $1x10^{-7}$ to $1x10^{-6}$/yr.

Savannah River Site. The same nitric acid tank and bermed area are assumed to be located at SRS. The tank contains 23,090 L (6,100 gal) of 80-percent nitric acid. The accident frequency is estimated to be in the range of $1x10^{-7}$ to $1x10^{-6}$/yr.

Scenario 5: Evaluation basis earthquake-induced release of plutonium. The forces from the seismic event are applied to the facility and confinement systems within the facility. For the source term analysis, both anchorage failures and support stand failures are assumed to cause enclosures to fall over. On impact with the floor, glove box windows may break or fall out, connecting rings and connections to exhaust ductwork may separate, and solution transfer lines may break. The enclosures may also fail structurally. For the source term analysis, if the seismic margins assessment shows that an enclosure will fail, it is assumed that the enclosure will be breached, and material that becomes airborne will be released to the laboratory. The building structure, high-efficiency particulate air (HEPA) filter plenums, and ductwork from the plenums to the structure will remain a functional confinement barrier following an earthquake.

Los Alamos National Laboratory. The accident frequency is estimated to be in the range of $1x10^{-6}$ to $1x10^{-4}$/yr. The release is calculated to be 0.61 g (0.02 oz) of plutonium metal.

Savannah River Site. This accident is also assumed to occur at SRS. The accident frequency is estimated to be in the range of $1x10^{-6}$ to $1x10^{-4}$/yr. The release is calculated to be 0.61 g (0.02 oz) of plutonium metal.

Scenario 6. Beyond evaluation basis earthquake-induced release of plutonium. The forces from the seismic event are applied to the facility and confinement systems within the facility. For the source term analysis, both anchorage failures and support stand failures are assumed to cause enclosures to fall over. On impact with the floor, glove box windows may break or fall out, connecting rings and connections to exhaust ductwork may separate, and solution transfer lines may break. The enclosures may also fail structurally. For the source term analysis, if the seismic margins assessment shows that an enclosure will fail, it is assumed that the enclosure will be breached, and material that becomes airborne will be released to the laboratory. For the beyond evaluation basis earthquake, the building structure, HEPA filter plenums, and ductwork from the plenums to the structure are assumed not to be functional confinement barriers.

Los Alamos National Laboratory. The accident frequency is estimated to be in the range of $1x10^{-7}$ to $1x10^{-6}$/yr. The release is calculated to be 0.63 g (0.02 oz) of plutonium metal.

Savannah River Site. This accident is also assumed to occur at SRS. The accident frequency is estimated to be in the range of $1x10^{-7}$ to $1x10^{-6}$/yr. The release is calculated to be 0.63 g (0.02 oz) of plutonium metal.

Scenario 7: Wet criticality. The wet criticality accident occurs in a glove box where the plutonium in solution exceeds the critical mass.

Los Alamos National Laboratory. The wet criticality accident that is postulated results in $5x10^{17}$ fissions. The frequency of occurrence of a criticality is estimated to be in the range of $1x10^{-7}$ to $1x10^{-6}$/yr.

Savannah River Site. The wet criticality is also assumed to occur at SRS. The accident results in $5x10^{17}$ fissions. The frequency of occurrence of a criticality is estimated to be in the range of $1x10^{-7}$ to $1x10^{-6}$/yr.

Scenario 8: Mechanical-induce
plutonium from a degraded stora
This postulated scenario assumes
dropped and the oxide contents spill
floor. The material at risk is assume
(9.9 lb) of plutonium oxide. No credit i
inner metal container (assumed to have
by the plutonium oxidation reactio
plastic bag (assumed to have deterio
outer package (assumed to be a slip-li
degraded seal).

Los Alamos National Laboratory. T
frequency is in the range of 0.01 to
release is estimated to be $7.2x10^{-12}$ g (
of plutonium oxide.

Savannah River Site. The accident fre
the range of 0.01 to 0.1/yr. The release
to be $7.2x10^{-12}$ g ($2.5x10^{-13}$ oz) of pluto

Scenario 9: Explosion-induced releas
nium. This postulated accident is the
chemical explosion in an ion-exchange c
explosion causes a breach of the glove b
ing the ion exchange column. It is assun
normal ventilation system is inoperable.

Los Alamos National Laboratory. Th
frequency is in the range of $1x10^{-4}$ to 0.
release of plutonium metal is estimated t
($1.76x10^{-3}$ oz).

Savannah River Site. The accident frequ
the range of $1x10^{-4}$ to 0.01/yr. The r
plutonium metal is estimated to b
($1.76x10^{-3}$ oz).

Scenario 10: Fire-induced release of p
on loading dock. This postulated scenari
a fire on the loading dock involving a co
plutonium contaminated waste drum. This
also assumes that the loading dock is op
atmosphere at the time of the fire.

Los Alamos National Laboratory. The
frequency is estimated to be in the range of
$1x10^{-4}$/yr. The release is calculated to
(0.03 oz) of plutonium oxide.

Savannah River Site. The accident frequency is estimated to be in the range of $1x10^{-6}$ to $1x10^{-}$ /yr. The release is calculated to be 0.8 g (0.03 oz) of plutonium oxide.

F.2.3.2 *Accident Consequences and Risk*

Tables F.2.3.2–1 and F.2.3.2–2 list the set of accidents selected to represent consequences and risks to workers and the public from accidental releases of radioactive materials during operations. For each accident, the table identifies the frequency of occurrence and the consequences to a hypothetical worker located at 1,000 m (3,281 ft) from the accident, a hypothetical individual located at the nearest site boundary, and the public out to a distance of 80 km (50 mi). The risks of cancer fatality for the worker, the individual at the site boundary, and the public for the composite set of accidents are also shown.

F.2.4 Nonintrusive Modification Pit Reuse

A set of potential accidents can be postulated for the nonintrusive modification pit reuse for which there may be releases of hazardous materials that may impact onsite workers and the public. Any such impacts, however, are expected to be bounded by the impacts associated with weapons A/D or pit fabrication.

F.2.5 High Explosives Fabrication

Evaluation basis accidents and beyond evaluation basis accidents have been studied for the HE fabrication operations. The studies postulated a set of accident scenarios that were representative of the risks and consequences for workers and the public from operations. Although not all potential accidents were addressed, those that were postulated have consequences and risks that are expected to envelop the consequences and risks of the relocated operations.

F.2.5.1 *Accident Scenarios and Consequences*

A range of hazardous conditions and potential accidents were reviewed as candidates to represent the risks to workers and the public of the HE fabrication operations. The physical releases (of chemicals and energy) from postulated accidents at the existing HE fabrication facilities at Pantex were used as an analog for potential releases at LANL and LLNL. A range of accidents was considered, from the release of particulates and dust through processing techniques, to the release of explosives from a fire or explosion, to the effects of blast pressure and fragment and debris scatter from an explosion.

The release of particulates and dust through processing operations would be contained where those operations occur. There is a probability in the range of 0.01 to 0.1/yr that the filtration systems fail during these operations. If there is filter failure, the operations would be halted. The releases from such accidents would have marginal effects (may cause minor occupational illnesses).

A release of chemical HE to the environment during a fire is estimated to occur with a probability in the range of $1x10^{-4}$ to 0.01/yr. Such a release would range up to 79 kg (175 lb) of explosives (released over a 10 minute period). The resulting environmental concentrations from a release, either triaminotrinitrobenzene (TATB) or TNT, of this magnitude were simulated. The TATB (which is representative of other explosives such as cyclotrimethylenetrinitramine [RDX] and cyclotetramethylenetetranitramine [HMX]) concentrations in the path of the plume would exceed the threshold limit value-time weighted average (TLV-TWA) of 1.5 mg/m^3 for distances up to 1,500, 2,200; and 2,400 m (5,000; 7,100; and 8,000 ft) from the release for Pantex, LLNL, and LANL, respectively. If the explosive were TNT, the plume concentrations would exceed the TLV-TWA limit of 0.5 milligrams (mg)/cubic meter (m^3) for distances up to 3,100; 4,500; and 5,000 m (10,200; 14,700; and 16,600 ft) from the release for Pantex, LLNL, and LANL, respectively. Concentrations of HE at each of the site boundaries would be 0.9, 54, and 50 mg/m^3, respectively. Concentrations of HE at 1,000 m (3,281 ft) from the fire (typical for a noninvolved worker) at each of the sites would be 3.0, 5.2, and 6.2 mg/m^3, respectively.

A release of chemical HE from the various processing facilities caused by an accidental explosion has a probability in the range of $1x10^{-4}$ to $1x10^{-6}$/yr. Such a release would range up to 79 kg (175 lb) of

TABLE F.2.3.2–1.—*Pit Fabrication and Intrusive Modification Pit Reuse at Savannah River Site, Impacts of Accidents*

Accident Scenario	Noninvolved Worker at 1,000 Meters		Maximum Offsite Individual		Population to 80 Kilometers		
	Dose (rem)	Probability of Cancer Fatality[a]	Dose (rem)	Probability of Cancer Fatality[a]	Dose (person-rem)	Cancer Fatalities	Accident Frequency (per year)
1. Fire-induced plutonium release from a glove box	0.035	1.4×10^{-5}	5.8×10^{-4}	2.9×10^{-7}	4.3	2.2×10^{-3}	1.0×10^{-3}
2. Operational release of tritium	6.5×10^{-3}	2.6×10^{-6}	1.1×10^{-4}	5.5×10^{-8}	0.79	4.0×10^{-4}	1.0×10^{-5}
5. Earthquake-induced release of plutonium – evaluation basis earthquake	0.099	4.0×10^{-5}	1.7×10^{-3}	8.4×10^{-7}	12.3	6.2×10^{-3}	1.0×10^{-5}
6. Earthquake-induced release of plutonium – beyond evaluation basis earthquake[b]	0.10	4.1×10^{-5}	1.7×10^{-3}	8.6×10^{-7}	12.8	6.4×10^{-3}	5.0×10^{-7}
7. Wet criticality[b]	8.5×10^{-4}	3.4×10^{-7}	1.4×10^{-5}	7.0×10^{-9}	0.019	9.5×10^{-6}	5.0×10^{-7}
8. Mechanical-induced release of plutonium	1.2×10^{-12}	4.7×10^{-16}	2.0×10^{-14}	9.9×10^{-18}	1.5×10^{-10}	7.3×10^{-14}	0.05
9. Explosion-induced release of plutonium	8.1×10^{-3}	3.3×10^{-6}	1.4×10^{-4}	6.9×10^{-8}	1.0	5.1×10^{-4}	1.0×10^{-3}
10. Fire-induced release of plutonium on loading dock	0.11	4.6×10^{-5}	1.9×10^{-3}	9.7×10^{-7}	14.3	7.2×10^{-3}	1.0×10^{-5}
Impacts for Composite Set of EBAs and BEBAs[c]							
Expected consequences[d]		3.5×10^{-7}		7.3×10^{-9}		5.4×10^{-5}	
Expected risk (per year)		1.8×10^{-8}		3.8×10^{-10}		2.8×10^{-6}	
Impacts for Composite Set of EBAs							
Expected consequences[d]		3.4×10^{-7}		7.3×10^{-9}		5.3×10^{-5}	
Expected risk (per year)		1.8×10^{-8}		3.8×10^{-10}		2.8×10^{-6}	
Impacts for Composite Set of BEBAs							
Expected consequences[d]		3.3×10^{-5}		4.4×10^{-7}		3.2×10^{-3}	
Expected risk (per year)		3.3×10^{-11}		4.4×10^{-13}		3.2×10^{-9}	

[a] Probability (increased likelihood) of cancer fatality to a hypothetical member of the public located at the site boundary or a worker located 1,000 m (3,281 ft) from the accident as a result of exposure to the indicated dose if the accident occurred.

[b] A beyond evaluation basis accident (BEBA). All other listed accidents are evaluation basis accidents (EBA).

[c] For the offsite population of 747,836, the average probability of cancer fatality/risk of cancer fatality (per year) for the composite set of accidents is $7.2\times10^{-11}/3.7\times10^{-12}$.

[d] Result of exposure to the indicated dose if the accident occurs.

Note: All values are mean values.

Source: Model results

TABLE F.2.3.2–2.—*Pit Fabrication and Intrusive Modification Pit Reuse at Los Alamos National Laboratory, Impacts of Accidents*

Accident Scenario	Noninvolved Worker at 1,000 Meters		Maximum Offsite Individual		Population to 80 Kilometers		
	Dose (rem)	Probability of Cancer Fatality[a]	Dose (rem)	Probability of Cancer Fatality[a]	Dose (person-rem)	Cancer Fatalities	Accident Frequency (per year)
1. Fire-induced plutonium release from a glove box	0.064	2.6×10^{-5}	0.035	1.7×10^{-5}	9.5	4.7×10^{-3}	1.0×10^{-3}
2. Operational release of tritium	0.012	4.8×10^{-6}	6.6×10^{-3}	3.3×10^{-6}	1.8	8.8×10^{-4}	1.0×10^{-5}
5. Earthquake-induced release of plutonium – evaluation basis earthquake	0.18	7.4×10^{-5}	0.099	5.0×10^{-5}	27.2	0.014	1.0×10^{-5}
6. Earthquake-induced release of plutonium – beyond evaluation basis earthquake[b]	0.19	7.6×10^{-5}	0.10	5.1×10^{-5}	28.1	0.014	5.0×10^{-7}
7. Wet criticality[b]	1.5×10^{-3}	6.1×10^{-7}	8.7×10^{-4}	4.4×10^{-7}	0.12	6.2×10^{-5}	5.0×10^{-7}
8. Mechanical-induced release of plutonium	2.2×10^{-12}	8.7×10^{-16}	1.2×10^{-14}	5.9×10^{-16}	3.2×10^{-10}	1.6×10^{-13}	0.05
9. Explosion-induced release of plutonium	0.015	6.1×10^{-6}	8.2×10^{-3}	4.1×10^{-6}	2.2	1.1×10^{-3}	1.0×10^{-3}
10. Fire-induced release of plutonium on loading dock	0.21	8.5×10^{-5}	0.12	5.7×10^{-5}	31.5	0.016	1.0×10^{-5}
Impacts for Composite Set of EBAs and BEBAs[c]							
Expected consequences[d]		6.4×10^{-7}		4.3×10^{-7}		1.2×10^{-4}	
Expected risk (per year)		3.3×10^{-8}		2.2×10^{-8}		6.2×10^{-6}	
Impacts for Composite Set of EBAs							
Expected consequences[d]		6.4×10^{-7}		4.3×10^{-7}		1.2×10^{-4}	
Expected risk (per year)		3.3×10^{-8}		2.2×10^{-8}		6.2×10^{-6}	
Impacts for Composite Set of BEBAs							
Expected consequences[d]		3.8×10^{-5}		2.6×10^{-5}		7.1×10^{-3}	
Expected risk (per year)		3.8×10^{-11}		2.6×10^{-11}		7.1×10^{-9}	

[a] Probability (increased likelihood) of cancer fatality to a hypothetical member of the public located at the site boundary or a worker located 1,000 m (3,281 ft) from the accident as a result of exposure to the indicated dose if the accident occurred.

[b] A beyond evaluation basis accident (BEBA). All other listed accidents are evaluation basis accidents (EBA).

[c] For the offsite population of 287,977, the average probability of cancer fatality/risk of cancer fatality (per year) for the composite set of accidents is $4.2\times10^{-10}/2.2\times10^{-11}$.

[d] Result of exposure to the indicated dose if the accident occurs.

Note: All values are mean values.

Source: Model results.

TATB (or HMX or RDX) or up to 29 kg (64 lb) of TNT. The explosive force from such an accident would result in elevating the HE to a height of 68 m (223 ft) before its downwind transport. The maximum concentration to those who could be exposed would be 6.7 mg/m^3 for TATB or 2.5 mg/m^3 for TNT, at a distance of 800 m (2,600 ft) from the release; this distance is offsite for LANL and LLNL but onsite for Pantex. The maximum offsite concentration at Pantex would be 3.2 mg/m^3 or 1.2 mg/m^3 for TATB or TNT, respectively. The TLV-TWA limits for TATB would be exceeded between 180 and 3,500 m (580 and 11,600 ft) from the release; these limits for TNT would be exceeded in the interval from 170 to 3,700 m (550 to 12,300 ft) from the release. The noninvolved worker (1,000 m [3,281 ft] from the explosion) could be exposed to TATB or TNT concentrations of 6.4 or 2.4 mg/m^3, respectively, essentially the maximum concentration found near the ground.

It should be noted that the TLV-TWA represents a TWA limit to a worker for a 40-hour workweek. The toxic exposures considered here are of a much shorter duration, on the order of minutes.

F.2.6 Storage of Plutonium Strategic Reserves

Evaluation basis accidents and beyond evaluation basis accidents have been studied for the storage of plutonium strategic reserves. The studies postulated a set of accident scenarios that were representative of the risks and consequences for workers and the public that can be expected from operations. Although not all potential accidents were addressed, those that were postulated have consequences and risks that are expected to envelop the consequences and risks of the relocated operations.

F.2.6.1 *Accident Scenarios and Source Terms*

A range of hazardous conditions and potent accidents were reviewed as candidates to repres the risks to workers and the public from operati this facility. Through a screening process, seve evaluation basis and beyond evaluation bas accidents were selected for further definition a analysis. A brief description of each of the accide scenarios and source terms is presented below. Tab F.2.6.1–1 presents a summary of each accide scenario and source term. Further detail can be fou in a topical report (HNUS 1996a).

Scenario 1: Fire-induced release of plutoniu from storage vault. The combustible materi within the vault mostly consists of tags and pape work. Further, the design and configuration of th vault preclude the introduction of combustibl materials in sufficient quantities to significantly alte the thermal environment. Therefore, the onl proposed method to initiate a fire in the vault is by th introducing and initiating large amounts of gasoline jet fuel, or other high-energy-density fuel. Addition ally, because of vault, storage container, and pi designs, not all of the pits stored in the vault woul be affected by the fire.

For an internal fire to cause some storage containers to fail through would take a sustained (more than 30-minute) exposure to a fire. Even if the storage container containing the pit fails, it is assumed that the material encapsulating the pit retains enough of its integrity so that no plutonium is released, or so that the contribution from pits is insignificant.

Pantex Plant. The accident frequency is estimated at 5×10^{-8}/yr. The release is estimated to be 11.4 g (0.4 oz) of plutonium oxide.

TABLE F.2.6.1–1.—*Accident Scenarios for Storage of Plutonium Strategic Reserves*

Accident Scenario	Site	Accident Frequency (per year)	Total Material Release to Environment
1. Fire-induced release of plutonium from storage vaults	Pantex	5×10^{-8}	11.4 g plutonium oxide
	NTS	Not applicable	Not applicable
2. Mechanical release of plutonium on loading dock	Pantex	6×10^{-4}	0.04 g plutonium oxide
	NTS	6×10^{-4}	0.04 g plutonium oxide

Source: HNUS 1996a.

Nevada Test Site. The vault fire accident is not considered to be a credible scenario because there is no conceivable way to get enough flammable material inside the underground vaults to make this accident possible.

Scenario 2: Mechanical release of plutonium on loading dock. In this postulated event, a forklift driver attempting to pick up a pallet containing pit storage containers in the shipping and receiving area punctures two of the storage containers. It is assumed that both storage containers contain pits, that the storage containers fall on the floor, and that any loose material in the form of powder is shaken out of the storage container onto the floor.

Pantex Plant. The accident frequency is $6x10^{-4}$/yr. The release is estimated to be 0.04 g ($1.41x10^{-3}$ oz) of plutonium oxide.

Nevada Test Site. This accident is assumed to occur at NTS at a frequency of $6x10^{-4}$/yr and release 0.04 g ($1.41x10^{-3}$ oz) of plutonium oxide.

F.2.6.2 *Accident Consequences and Risk*

Tables F.2.6.2–1 and F.2.6.2–2 list the set of accidents selected to represent consequences and risks to workers and the public from accidental releases of radioactive materials during operations at Pantex and NTS, respectively. For each accident, the table identifies the frequency of occurrence and the consequences to a hypothetical worker located at 1,000 m (3,281 ft) from the accident, a hypothetical individual located at the nearest site boundary, and the public out to a distance of 80 km (50 mi). The risks of cancer fatality for the worker, the individual at the site boundary, and the public for the composite set of accidents are also shown.

F.2.7 Storage of Uranium Strategic Reserves

Studies of evaluation basis accidents and beyond evaluation basis accidents have been performed for the storage of uranium strategic reserves. The studies postulated a set of accident scenarios that were representative of the risks and consequences for workers and the public that can be expected from operations. Although not all potential accidents were addressed, those that were postulated have consequences and risks that are expected to envelop the consequences and risks of the relocated operations. In this manner, no other credible accidents with an expected frequency of occurrence larger than 10^{-7}/yr are anticipated that will have consequences and risks larger than those described in this section.

F.2.7.1 *Accident Scenarios and Source Terms*

A range of hazardous conditions and potential accidents were reviewed as candidates to represent the risks to workers and the public from facility operation. Through a screening process, several evaluation basis accidents and beyond evaluation basis accidents were selected for further definition and analysis. A brief description of each of the five accident scenarios and source terms is presented below. Table F.2.7.1–1 presents a summary of each accident scenario and source term. Further detail can be found in a topical report (HNUS 1996a).

Scenario 1: Criticality. Criticality accidents were considered for routine handling in storage areas. Hypothetical scenarios were analyzed in the tube vault involving loading and unloading activities that might result in criticality. A facility worker could accidentally overdraw and drop a loaded tube tray, allowing the cans to fall and tumble into a critical pile. A criticality accident could also result from overloading the tube vault (spacing between slots on tube trays physically prevents overloading). A forklift could accidentally crush or jam a sufficient number of cans together to cause a criticality accident (spacing between the slots also makes it physically impossible for a forklift to accidentally crush or jam a sufficient number of cans together to cause a criticality accident).

Oak Ridge Reservation. The probability of a criticality in the vault area is assumed to be in the range of $1x10^{-6}$ to $1x10^{-4}$/yr. A single pulse of $1x10^{17}$ fissions is produced before the solid matrix disassembles.

Pantex Plant. The probability of a criticality in the vault area is assumed to be in the range of $1x10^{-6}$ to $1x10^{-4}$/yr. A single pulse of $1x10^{17}$ fissions is produced before the solid matrix disassembles.

Nevada Test Site. The probability of a criticality in the vault area is assumed to be in the range of $1x10^{-6}$

TABLE F.2.6.2–1.—*Storage of Plutonium Strategic Reserves at Pantex Plant, Impacts of Accidents*

Accident Scenario	Maximum Worker at 1,000 Meters		Maximum Offsite Individual		Population to 80 Kilometers		
	Dose (rem)	Probability of Cancer Fatality[a]	Dose (rem)	Probability of Cancer Fatality[a]	Dose (person-rem)	Cancer Fatalities	Accident Frequency (per year)
1. Fire-induced release of plutonium from storage vaults[b]	1.6	6.4×10^{-4}	0.51	2.6×10^{-4}	59	0.03	5.0×10^{-8}
2. Mechanical release of plutonium from loading dock	5.6×10^{-3}	2.3×10^{-6}	1.8×10^{-3}	9.0×10^{-7}	0.21	1.0×10^{-4}	6.0×10^{-4}
Impacts for Composite Set of EBAs and BEBAs[c]							
Expected consequences[d]		2.3×10^{-6}		9.2×10^{-7}		1.1×10^{-4}	
Expected risk (per year)		1.4×10^{-9}		5.5×10^{-10}		6.4×10^{-8}	
Impacts for Composite Set of EBAs							
Expected consequences[d]		2.3×10^{-6}		9.0×10^{-7}		1.0×10^{-4}	
Expected risk (per year)		1.4×10^{-9}		5.4×10^{-10}		6.2×10^{-8}	
Impacts for Composite Set of BEBAs							
Expected consequences[d]		6.4×10^{-4}		2.6×10^{-4}		0.03	
Expected risk (per year)		3.2×10^{-11}		1.3×10^{-11}		1.5×10^{-9}	

[a] Probability (increased likelihood) of cancer fatality to a hypothetical member of the public located at the site boundary or a worker located 1,000 m (3,281 ft) from the accident as a result of exposure to the indicated dose if the accident occurred.

[b] A beyond evaluation basis accident (BEBA). All other listed accidents are evaluation basis accidents (EBA).

[c] For the offsite population of 285,409, the average probability of cancer fatality/risk of cancer fatality (per year) for the composite set of accidents is $3.0 \times 10^{-10}/2.2 \times 10^{-13}$.

[d] Result of exposure to the indicated dose if the accident occurs.

Note: All values are mean values.

Source: Model results.

TABLE F.2.6.2–2.—*Storage of Plutonium Strategic Reserves at Nevada Test Site, Impacts of Accidents*

Accident Scenario	Noninvolved Worker at 1,000 Meters		Maximum Offsite Individual		Population to 80 Kilometers		
	Dose (rem)	Probability of Cancer Fatality[a]	Dose (rem)	Probability of Cancer Fatality[a]	Dose (person-rem)	Cancer Fatalities	Accident Frequency (per year)
1. Fire-induced release of plutonium from storage vaults[b]	[c]	[c]	[c]	[c]	[c]	[c]	[c]
2. Mechanical release of plutonium from loading dock	9.6×10^{-3}	3.8×10^{-6}	1.8×10^{-4}	8.9×10^{-8}	0.013	6.5×10^{-6}	6.0×10^{-4}
Impacts for Composite Set of EBAs and BEBAs							
Expected consequences[d]		[e]		[e]		[e]	
Expected risk (per year)		[e]		[e]		[e]	
Impacts for Composite Set of EBAs[b]							
Expected consequences[d]		3.8×10^{-6}		8.9×10^{-8}		6.5×10^{-6}	
Expected risk (per year)		2.3×10^{-9}		5.3×10^{-11}		3.9×10^{-9}	
Impacts for Composite Set of BEBAs							
Expected consequences[d]		[e]		[e]		[e]	
Expected risk (per year)		[e]		[e]		[e]	

[a] Probability (increased likelihood) of cancer fatality to a hypothetical member of the public located at the site boundary or a worker located 1,000 m (3,281 ft) from the accident as a result of exposure to the indicated dose if the accident occurred.

[b] For the offsite population of 18,517, the average probability of cancer fatality/risk of cancer fatality (per year) for the composite set of accidents is $3.5\times10^{-10}/2.1\times10^{-13}$.

[c] The accident is not possible at NTS.

[d] Result of exposure to the indicated dose if the accident occurs.

[e] No beyond evaluation basis accidents were identified for NTS. The impacts for the composite set of EBAs and BEBAs is the same as the impacts for the composite set of EBAs.

Note: All values are mean values.

Source: Model results.

to $1x10^{-4}$/yr. A single pulse of $1x10^{17}$ fissions is produced before the solid matrix disassembles.

Scenario 2: Fire-induced release of highly enriched uranium from aircraft crash. An aircraft crash into the vault area, followed by a large fire, bounds the potential consequences associated with the facility. The concern then rises that the multiple barriers of some of the stored HEU could be breached solely because of the crash itself. It is estimated that an engine block penetrating the facility might impact 15 percent of the available containers. Therefore, it is assumed that the impacted 15 percent would be subject to release in the first ten minutes of the fire. Because of the insulated shipping containers, after one hour it is assumed that 1 percent of the total inventory would be available for release. To assume that any impact results in a complete release of the encased materials is a conservative assumption and is used for the purposes of this bounding study.

Oak Ridge Reservation. This accident is not applicable to ORR because the probability of an aircraft crash into a facility is much less than 10^{-7}/yr.

Pantex Plant. This accident is considered a beyond evaluation basis accident ($1x10^{-7}$/yr). The release for radiological impacts is 270 g (9.5 oz) chemical toxicity impacts, the release is (s) for 10 minutes then 1.7 g/s for the s the accident.

Nevada Test Site. This accident is not NTS because the probability of an aircra facility is much less than 10^{-7}/yr.

Scenario 3: Fire-induced release of an aircraft crash. Of the chemical ac ios, no mechanisms were identified that tially release a significant amount of lit or uranium to the environment, otl potential jet fuel-fed fires following an A large aircraft crash with significant s fire is therefore assumed to be the boundi chemical accident. The release scenaric scenario 2.

Oak Ridge Reservation. This accident is ble to ORR because the probability of an into a facility is much less than 10^{-7}/yr.

Pantex Plant. This accident is consider evaluation basis accident ($1x10^{-7}$/yr). I toxicity impacts, the release is 2.5 g/s fo then 2.8 g/s for the second hour of the ac

TABLE F.2.7.1-1.—*Accident Scenarios for Storage of Uranium Strategic Reser*

Accident Scenario	Site	Accident Frequency (per year)	Total Materi to Enviro
1. Criticality	ORR	$1x10^{-6}$ to $1x10^{-4}$	$1x10^{17}$ fissior
	Pantex	$1x10^{-6}$ to $1x10^{-4}$	$1x10^{17}$ fission
	NTS	$1x10^{-6}$ to $1x10^{-4}$	$1x10^{17}$ fission
2. Fire-induced release of HEU from aircraft crash	ORR	not applicable	
	Pantex	$1x10^{-7}$	270 grams of
	NTS	not applicable	
3. Fire-induced release of lithium hydride from aircraft crash	ORR	not applicable	
	Pantex	$1x10^{-7}$	2.5 g/s to 2.8 g
	NTS	not applicable	
4. Fire-induced release of HEU from vault	ORR	$1x10^{-6}$ to $1x10^{-4}$	37.64 kg HEU
	Pantex	$1x10^{-6}$ to $1x10^{-4}$	37.64 kg HEU
	NTS	$1x10^{-6}$ to $1x10^{-4}$	37.64 kg HEU
5. Explosive release of HEU from vault	ORR	$1x10^{-6}$ to $1x10^{-4}$	540 grams of H
	Pantex	$1x10^{-6}$ to $1x10^{-4}$	540 grams of H
	NTS	$1x10^{-6}$ to $1x10^{-4}$	540 grams of H

Source: HNUS 1996a.

Nevada Test Site. This accident is not applicable to NTS because the probability of an aircraft crash into a facility is much less than 10^{-7}/yr.

Scenario 4: Fire-induced release of highly enriched uranium. It is assumed that 3,785 L (1,000 gal) of fuel are inserted into the vault area and that a pool 0.64-cm (1/4-in) deep develops. The area covered by that pool will be approximately 595 m^2 (6,400 ft^2). It is assumed that only in the innermost 20 percent of the fire will temperatures be sufficient to ignite uranium, and that only the topmost of the three drums will reach those temperatures, the lower ones being cooled through conduction to the vault base and the fuel. Of the drums reaching those temperatures, half are assumed to fail and, of those, half fail at the bottom, releasing some or all of their contents. The drum density in the new vault areas is approximately one set of three per 0.9 to 1.0 m^2 (10 to 11 ft^2). Thus, 1,920 drums will be within the fire, and 128 of them will reach high enough temperatures to ignite the uranium, of which 32 will fail at the bottom and expel their contents.

Oak Ridge Reservation. The frequency of this accident is assumed to be in the range of $1x10^{-6}$ to $1x10^{-4}$/yr. The amount estimated to be released will be 37,640 g (1,328 oz).

Pantex Plant. The frequency of this accident is assumed to be in the range of $1x10^{-6}$ to $1x10^{-4}$/yr. The amount estimated to be released will be 37,640 g (1,328 oz).

Nevada Test Site. The frequency of this accident is assumed to be in the range of $1x10^{-6}$ to $1x10^{-4}$/yr. The amount estimated to be released will be 37,640 g (1,328 oz).

Scenario 5: Explosion-induced release of highly enriched uranium from vault. In an explosion, it is assumed that the drums and cans will provide sufficient protection to prevent the uranium from igniting. Consequently, even though there may be significant damage to the drums and/or cans, since the metal contents have not oxidized or vaporized, there is assumed to be no release. For those cans containing powders, the situation is different, in that the powder may spill from the drum and then be released. It is assumed that the storage arrangement will protect all but the "front row" of cans. Considering a 5x4 arrangement in the pallet, and using the side with five cans, about 25 percent of the cans will feel the blast. Thus, about 250 cans may be damaged. However, it is assumed that only 100 cans, representing the faces of the four closest stacks of pallets, are sufficiently damaged to spill their contents.

Oak Ridge Reservation. Assuming that half the contents of each of the 100 cans spill, 540 g (19 oz) will be released. The estimated probability is in the range of $1x10^{-6}$ to $1x10^{-4}$/yr.

Pantex Plant. Assuming that half the contents of each of the 100 cans spill, 540 g (19 oz) will be released. The estimated probability is in the range of $1x10^{-6}$ to $1x10^{-4}$/yr.

Nevada Test Site. Assuming that half the contents of each of the 100 cans spill, 540 g (19 oz) will be released. The estimated probability is in the range of $1x10^{-6}$ to $1x10^{-4}$/yr.

F.2.7.2 *Accident Consequences and Risk*

Table F.2.7.2–1 lists the set of accidents selected to represent consequences and risks to workers and the public from accident releases of radioactive materials and other hazardous effects during operations at ORR. For each accident, the table identifies the frequency of occurrence, and the consequences to a hypothetical worker at a specified distance from the accident, a hypothetical individual located at the nearest site boundary, and the public out to a distance of 80 km (50 mi). The risks of cancer fatality for the worker, the individual at the site boundary, and the public for the composite set of accidents are also shown.

F.3 Comparison of the No Action Alternative to Proposed Alternatives at Pantex Plant and Oak Ridge Reservation

F.3.1 Pantex Plant

Existing operations at Pantex that have the potential for risks to workers and the public are weapons A/D and storage of plutonium. Under the No Action alternative storage would continue in Zone 4 and weapons A/D would continue in Zones 4 and 12. The

TABLE F.2.7.2–1.—*Storage of Uranium Strategic Reserves at Oak Ridge Reservation, Impacts of Accidents*

Accident Scenario	Noninvolved Worker at 619 Meters		Maximum Offsite Individual		Population to 80 Kilometers		
	Dose (rem)	Probability of Cancer Fatality[a]	Dose (rem)	Probability of Cancer Fatality[a]	Dose (person-rem)	Cancer Fatalities	Accident Frequency (per year)
1. Criticality	5.1×10^{-4}	2.0×10^{-7}	5.1×10^{-4}	2.5×10^{-7}	0.031	1.5×10^{-5}	1.0×10^{-5}
4. Fire-induced release of highly enriched uranium from vault	5.4	2.2×10^{-3}	5.4	2.7×10^{-3}	806	0.40	1.0×10^{-5}
5. Explosive release of highly enriched uranium from vault	0.077	3.1×10^{-5}	0.077	3.9×10^{-5}	11.6	5.8×10^{-3}	1.0×10^{-5}
Impacts for Composite Set of EBAs and BEBAs[b]							
Expected consequences[c]		7.3×10^{-4}		9.1×10^{-4}		0.14	
Expected risk (per year)		2.2×10^{-8}		2.7×10^{-8}		4.1×10^{-6}	
Impacts for Composite Set of EBAs							
Expected consequences[c]		[d]		[d]		[d]	
Expected risk (per year)		[d]		[d]		[d]	
Impacts for Composite Set of BEBAs							
Expected consequences[c]		[e]		[e]		[e]	
Expected risk (per year)		[e]		[e]		[e]	

[a] Probability (increased likelihood) of cancer fatality to a hypothetical member of the public located at the site boundary or to a worker located 619 m from the accident as a result of exposure to the indicated dose if the accident occurred.

[b] For the offsite population of 1,096,144, the average probability of cancer fatality/risk of cancer fatality (per year) for the composite set of accidents is $1.3 \times 10^{-7}/3.7 \times 10^{-12}$.

[c] Result of exposure to the indicated dose if the accident occurs.

[d] The impacts of evaluation basis accidents (EBA) are identical to the data shown in this table.

[e] All accidents are in the frequency range of 10^{-6} to 10^{-4} per year and are grouped together as EBAs. As a result, there are no impacts shown for beyond evaluation basis accidents (BEBA).

Note: All values are mean values.

Source: Model results.

risks of accidents to workers and the public are addressed in applicable SARs and would not be expected to change if they were continued. Under the proposed actions, weapons A/D operations would be entirely relocated to Zone 12.

Through relocation, the A/D operations would be performed in existing, modern facilities resulting in a decrease in the facility footprint in Zone 12 compared to the footprint in Zone 4. Although the risks of accidents due to internal initiators like fires and explosions are not expected to decrease significantly, risks would be reduced through the engineered safety features of a modern facility. More importantly, all Zone 4 operations have a higher probability of an externally initiated accident caused by an aircraft crash because Zone 4 is closer to the nearby commercial airport and traffic patterns than Zone 12. The probability of an aircraft crash into a Zone 12 facility is also decreased as a result of a reduction in the size of the facility compared to the existing facilities in Zone 4.

F.3.2 Oak Ridge Reservation

Existing operations at ORR that have the potential for risks to workers and the public are secondary and case fabrication and storage of HEU. Under the No Action alternative, these operations would continue to be performed in the facilities where they presently exist. The risks of accidents to workers and the public are addressed in applicable SARs and would not be expected to change if they were to be continued.

Under the proposed actions, secondary and case fabrication and HEU storage would be downsized into fewer existing buildings in the same vicinity as buildings associated with the No Action alternative. The risks of accidents to workers and the public from internal causes such as fires and criticality are not expected to change. However, all of the buildings that would perform the downsized operations would be upgraded to meet natural phenomena requirements. These upgrades are expected to reduce risks, which would not happen under the No Action alternative.

F.4 Secondary Impacts of Accidents

The primary impacts of accidents are measured in terms of public and worker exposures to radiation and toxic chemicals. The secondary impacts of accidents include all elements of the environment. For example, if an accident occurred, a radiological release may contaminate farmland, surface and underground water, recreational areas, industrial parks, historical sites, or the habitat of an endangered species. As a result, farm products may have to be destroyed; the supply of drinking water may be lowered; recreational areas may be closed; industrial parks may suffer economic losses during shutdown for decontamination; historical sites may have to be closed to visitors; and the endangered species may move closer to extinction.

This section addresses the secondary impacts of a high consequence EBA and BEBA in the region of a radiological release. The accidents were selected to illustrate the effects of accidents evaluated for each of the technologies. The levels of radioactivity that have a potential for secondary effects are based on analysis using the MACCS computer code with 50 percent meteorology conditions for each site.

The region of secondary effects extends out from the point of release in a pattern formed by dispersion parameters such as meteorology. The level of exposure is generally decreasing with increasing distance from the release point. Figures F.4.1.–1 through F.4.6–2 show the shapes of patterns for each site at a distance at which the level of radioactivity from the accidental release would be higher than the level of radioactivity from natural background at each site.

These results are useful for comparing the environmental sensitivity of sites with respect to the secondary impacts for an accidental radiological release. In reviewing the results, it is useful to note whether the impacted area extends beyond the site boundary where the economic impacts would be larger than if the area were contained within the site boundary. It is also useful to note the size of the contaminated area in which the level of radioactivity exceeds exposures from natural background.

F.4.1 Oak Ridge Reservation

In the region of ORR, the natural background level of radiation (excluding radon) is 95 millirems (mrem)/yr, plus an additional 200 mrem from radon.

The results shown in figures F.4.1–1 and F.4.1–2 indicate the radiation levels at various distances from the accident. Section 4.2 describes the land, water, biotic, cultural, paleontological, and socioeconomic resources in the ORR environment that may receive secondary impacts from accidents.

F.4.2 Savannah River Site

In the region of SRS, the natural background level of radiation (excluding radon) is 98 mrem/yr, plus an additional 200 mrem from radon. The results shown in figure F.4.2–1 indicate the radiation levels at various distances from the accident. Section 4.3 describes the land, water, biotic, cultural, paleontological, and socioeconomic resources in the SRS environment that may receive secondary impacts from accidents.

F.4.3 Pantex Plant

In the region of Pantex, the natural background level of radiation (excluding radon) is 134 mrem /yr, plus an additional 200 mrem from radon. The results shown in figures F.4.3–1 and F.4.3–2 indicate the radiation levels at various distances from the accident. Section 4.5 describes the land, water, biotic, cultural, paleontological, and socioeconomic resources in the Pantex environment that may receive secondary impacts from accidents.

F.4.4 Los Alamos National Laboratory

In the region of LANL, the natural background level of radiation (excluding radon) is 140 mrem/yr, plus an additional 200 mrem from radon. The results shown in figures F.4.4–1 and F.4.4–2 indicate t radiation levels at various distances from tl accident. Section 4.6 describes the land, water, biot cultural, paleontological, and socioeconom resources in the LANL environment that may recei secondary impacts from accidents.

F.4.5 Lawrence Livermore National Laborator

In the region of LLNL, the natural background lev of radiation (excluding radon) is 100 mrem per/y plus an additional 200 mrem from radon. The result shown in figure F.4.5–1 indicate the radiation levels a various distances from the accident. Section 4.: describes the land, water, biotic, cultural, paleonto logical, and socioeconomic resources in the LLNL environment that may receive secondary impacts from accidents.

F.4.6 Nevada Test Site

In the region of NTS, the natural background level of radiation (excluding radon) is 113 mrem per/yr, plus an additional 200 mrem from radon. The results shown in figures F.4.6–1 and F.4.6–2 indicate the radiation levels at various distances from the accident. Section 4.9 describes the land, water, biotic, cultural, paleontological, and socioeconomic resources in the NTS environment that may receive secondary impacts from accidents.

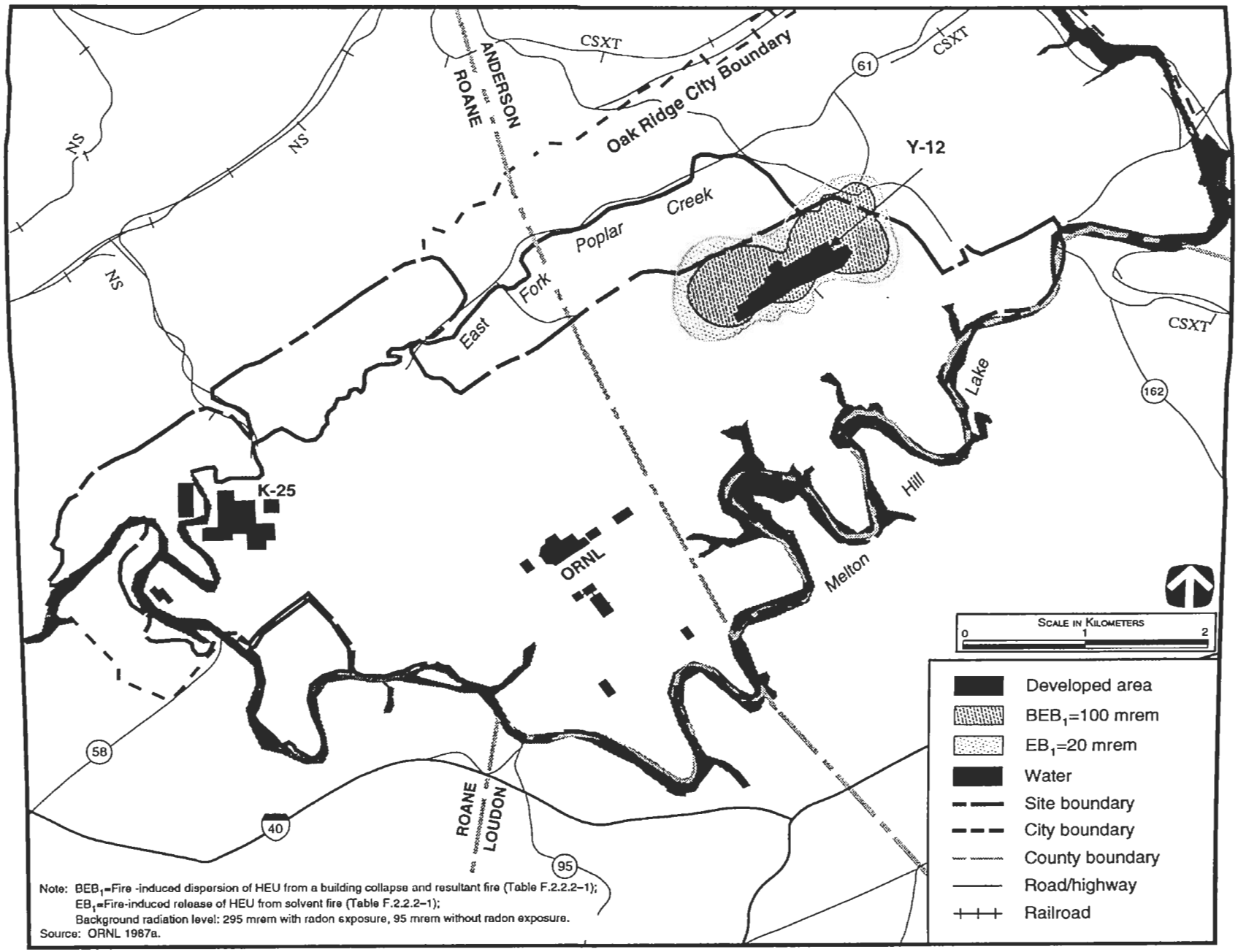
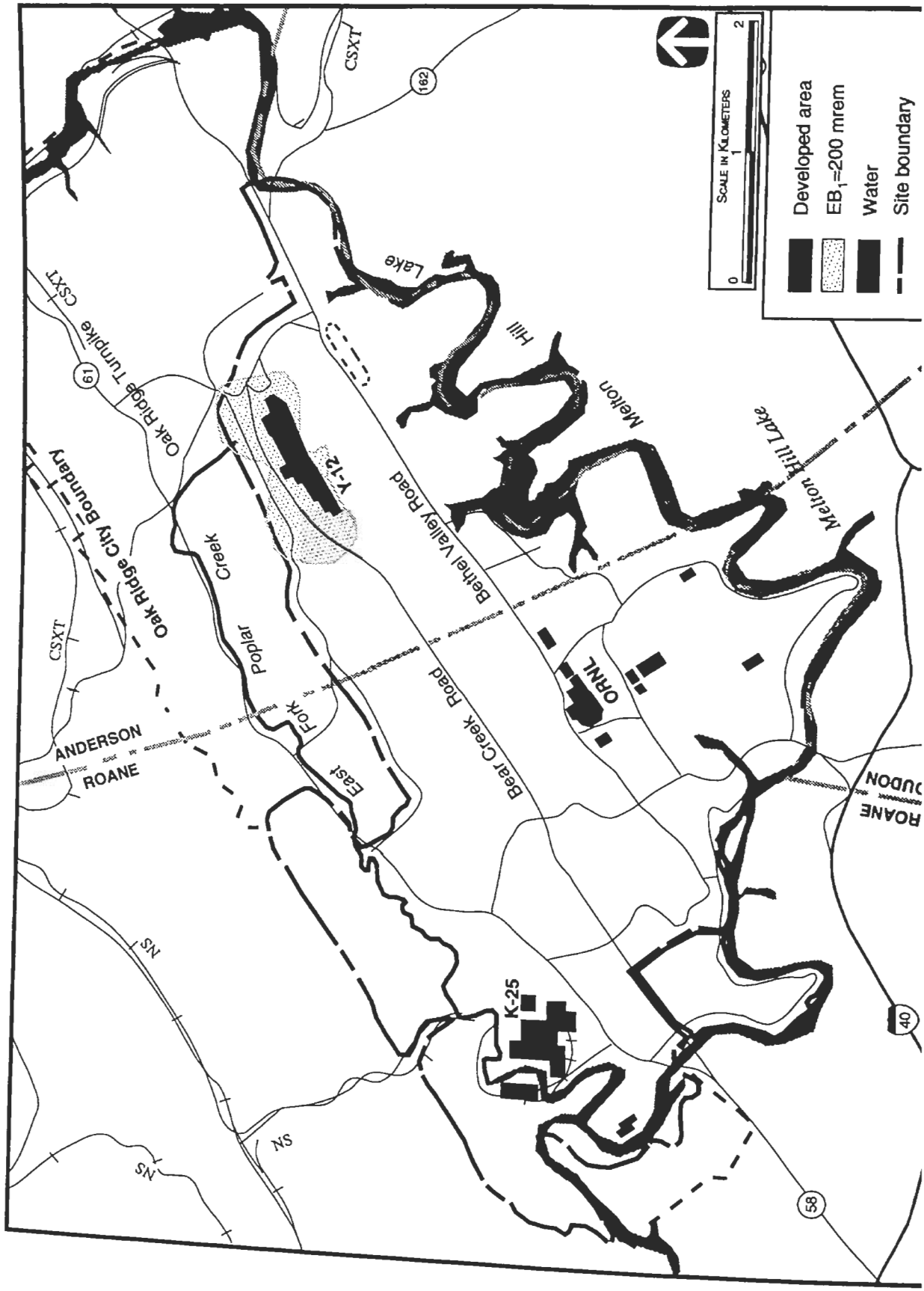


FIGURE F.4.1–1.—*Areas of Surface Exposure for Secondary and Case Fabrication Accidents at Oak Ridge Reservation.*


Developed area
EB1=200 mrem
Water
Site boundary
Scale in Kilometers
0
1
2
CSXT
162
Lake
Hill
Melton
Melton Hill Lake
Oak Ridge Turnpike
61
Oak Ridge City Boundary
Y-12
Bethel Valley Road
Poplar
Creek
East
Fork
Bear Creek Road
ORNL
ANDERSON
ROANE
K-25
NS
40
58

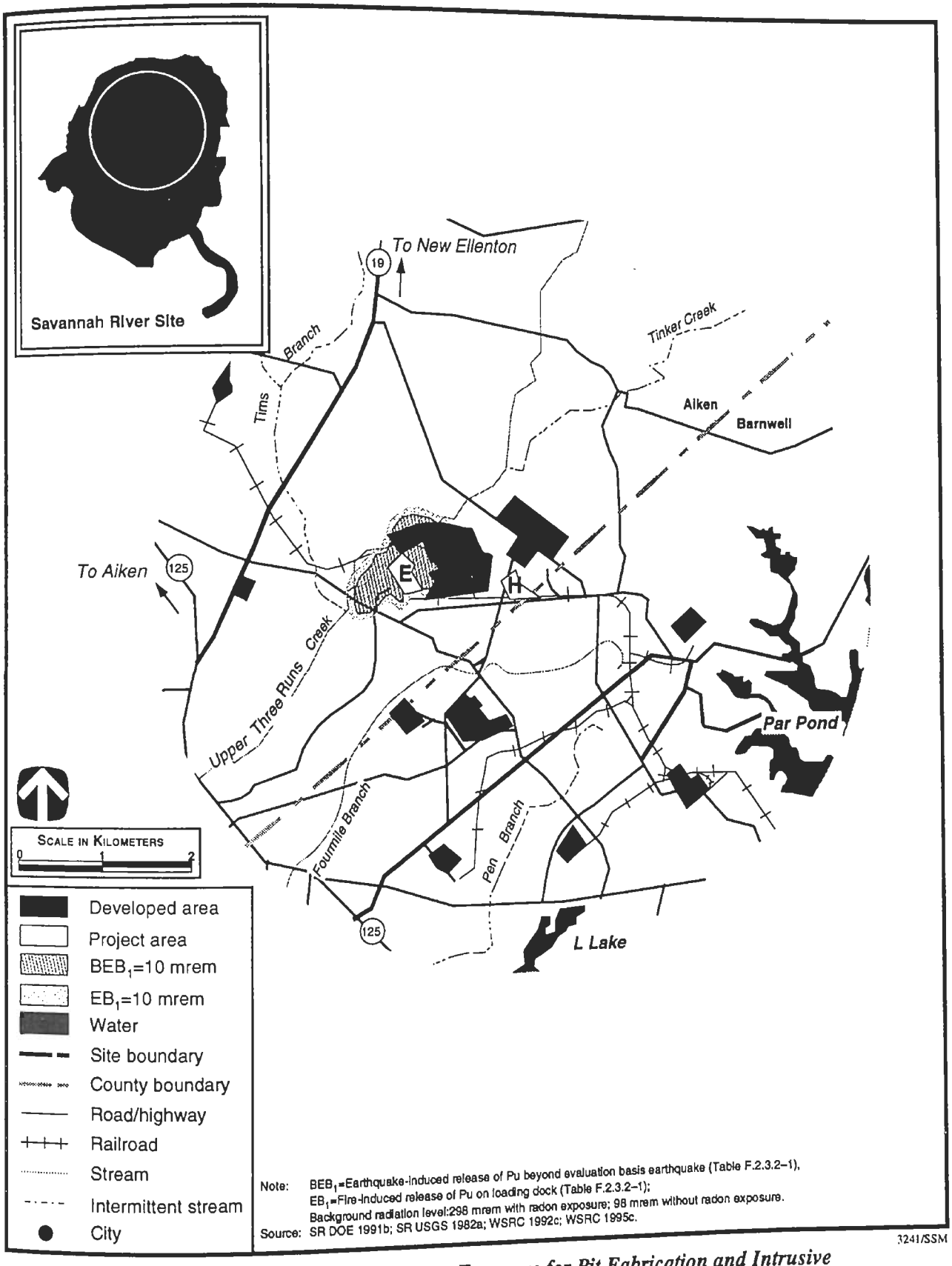


FIGURE F.4.2–1.—*Areas of Surface Exposure for Pit Fabrication and Intrusive Modification Reuse Accidents at Savannah River Site.*

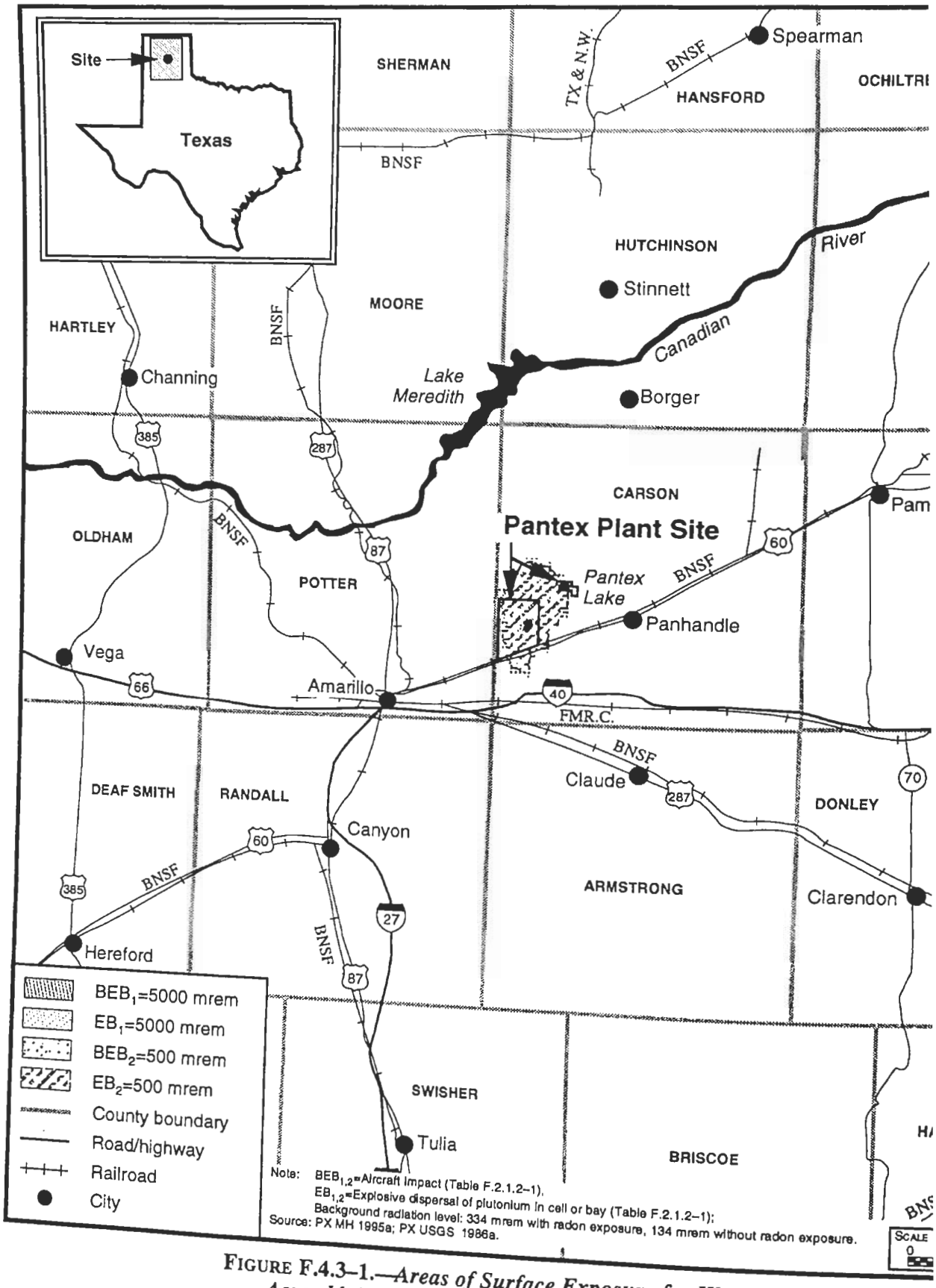


FIGURE F.4.3–1.—*Areas of Surface Exposure for Weapons Assembly/Disassembly Accidents at Pantex Plant.*

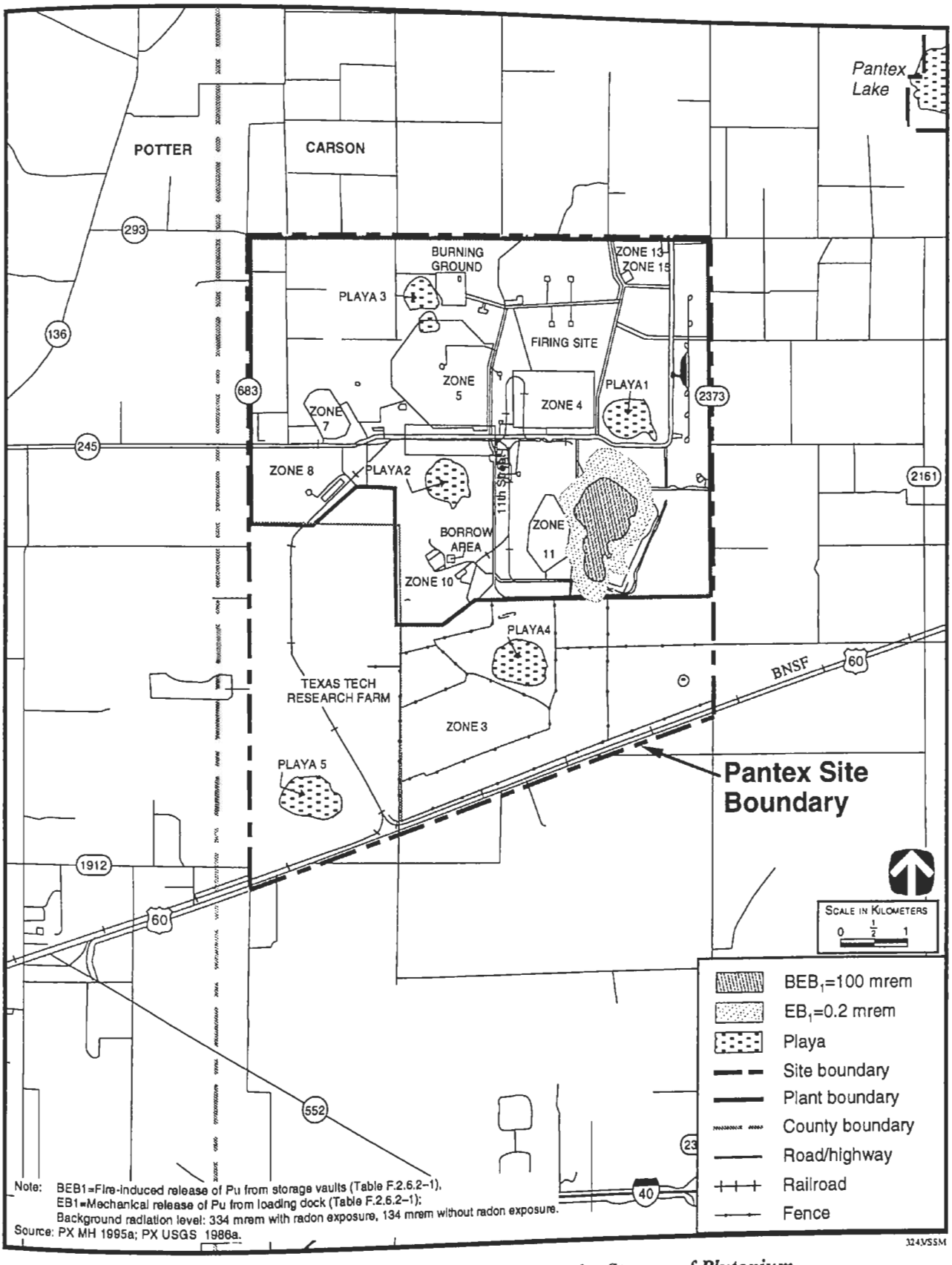


FIGURE F.4.3–2.—*Areas of Surface Exposure for Storage of Plutonium Strategic Reserve Accidents at Pantex Plant.*

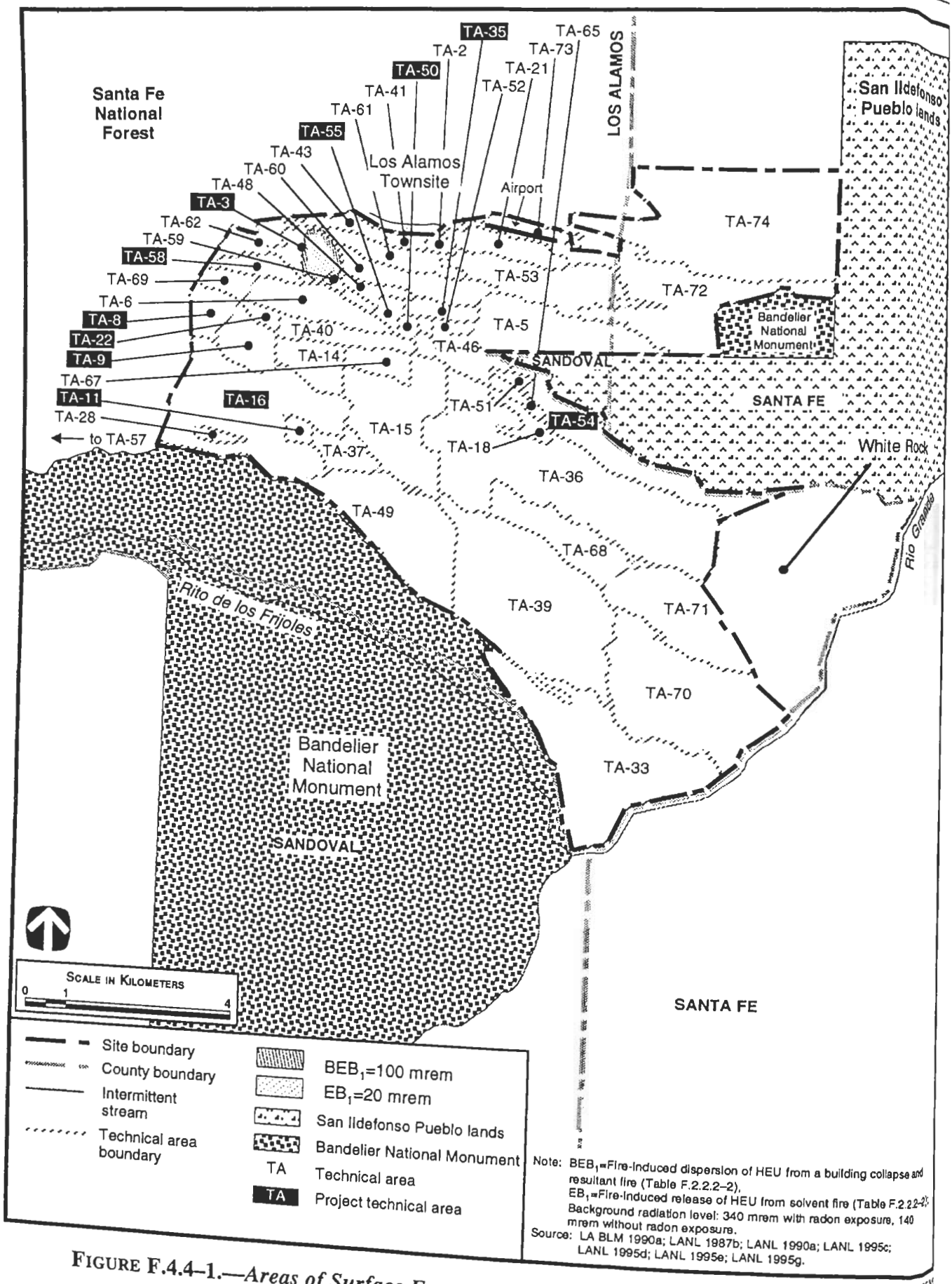


FIGURE F.4.4–1.—*Areas of Surface Exposure for Secondary and Case Fabrication Accidents at Los Alamos National Laboratory.*

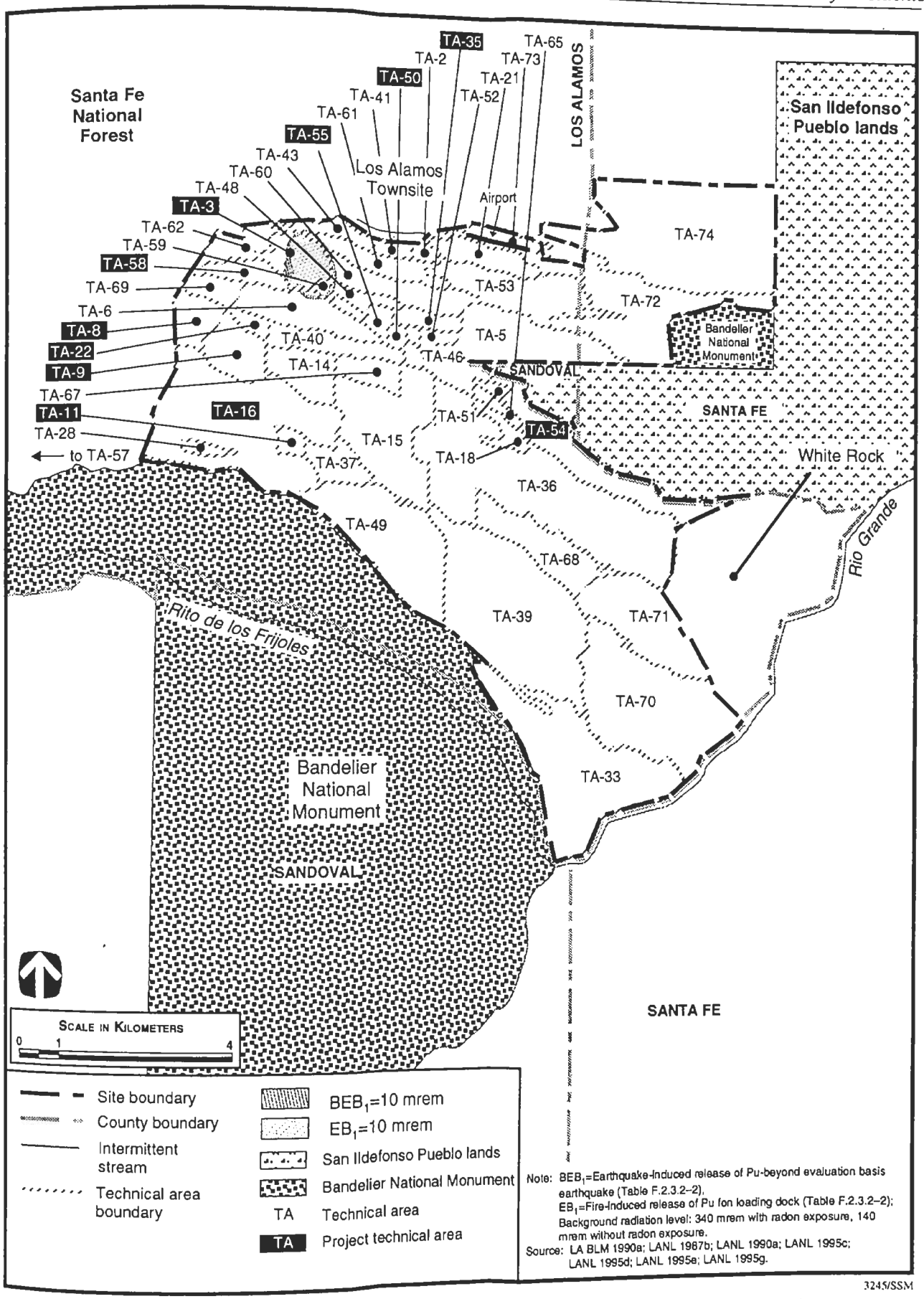


FIGURE F.4.4–2.—*Areas of Surface Exposure for Pit Fabrication and Intrusive Modification Reuse at Los Alamos National Laboratory.*

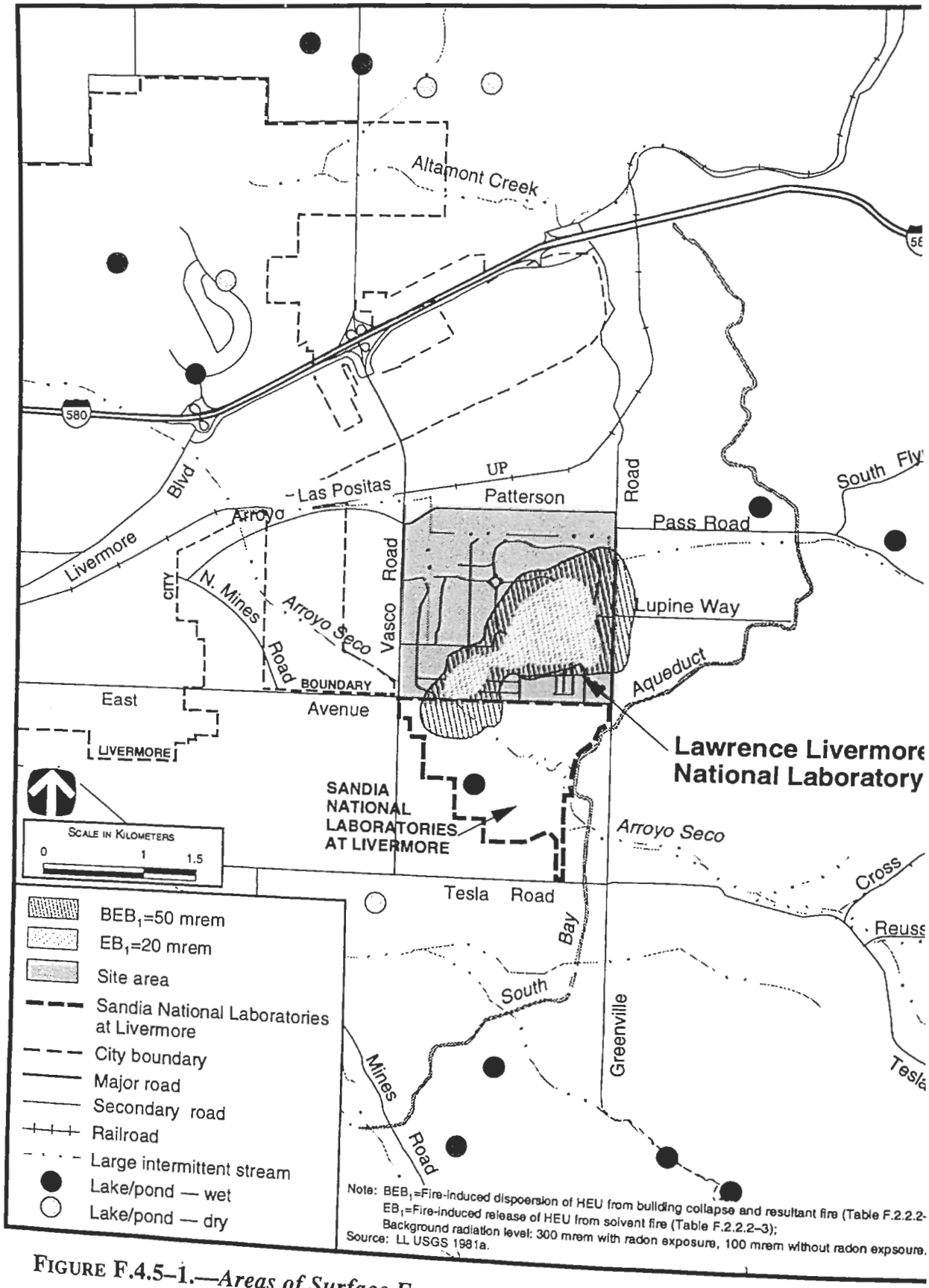
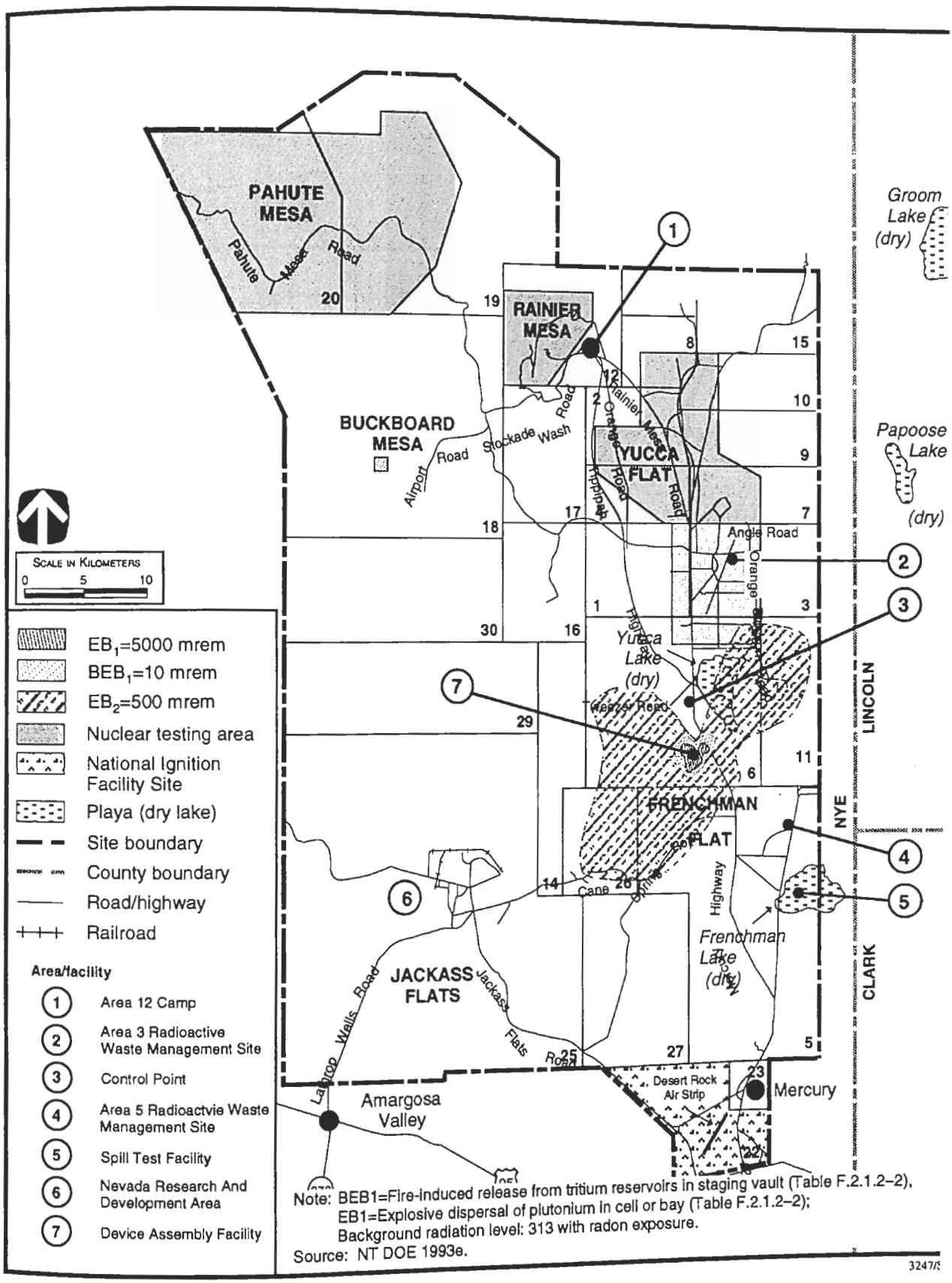


FIGURE F.4.5–1.—*Areas of Surface Exposure for Secondary and Case Fabrication Ac at Lawrence Livermore National Laboratory.*



Note: BEB1=Fire-induced release from tritium reservoirs in staging vault (Table F.2.1.2–2), EB1=Explosive dispersal of plutonium in cell or bay (Table F.2.1.2–2); Background radiation level: 313 with radon exposure.

Source: NT DOE 1993e.

FIGURE F.4.6–1.—*Areas of Surface Exposure for Weapons Assembly/Disassembly Accidents at Nevada Test Site.*

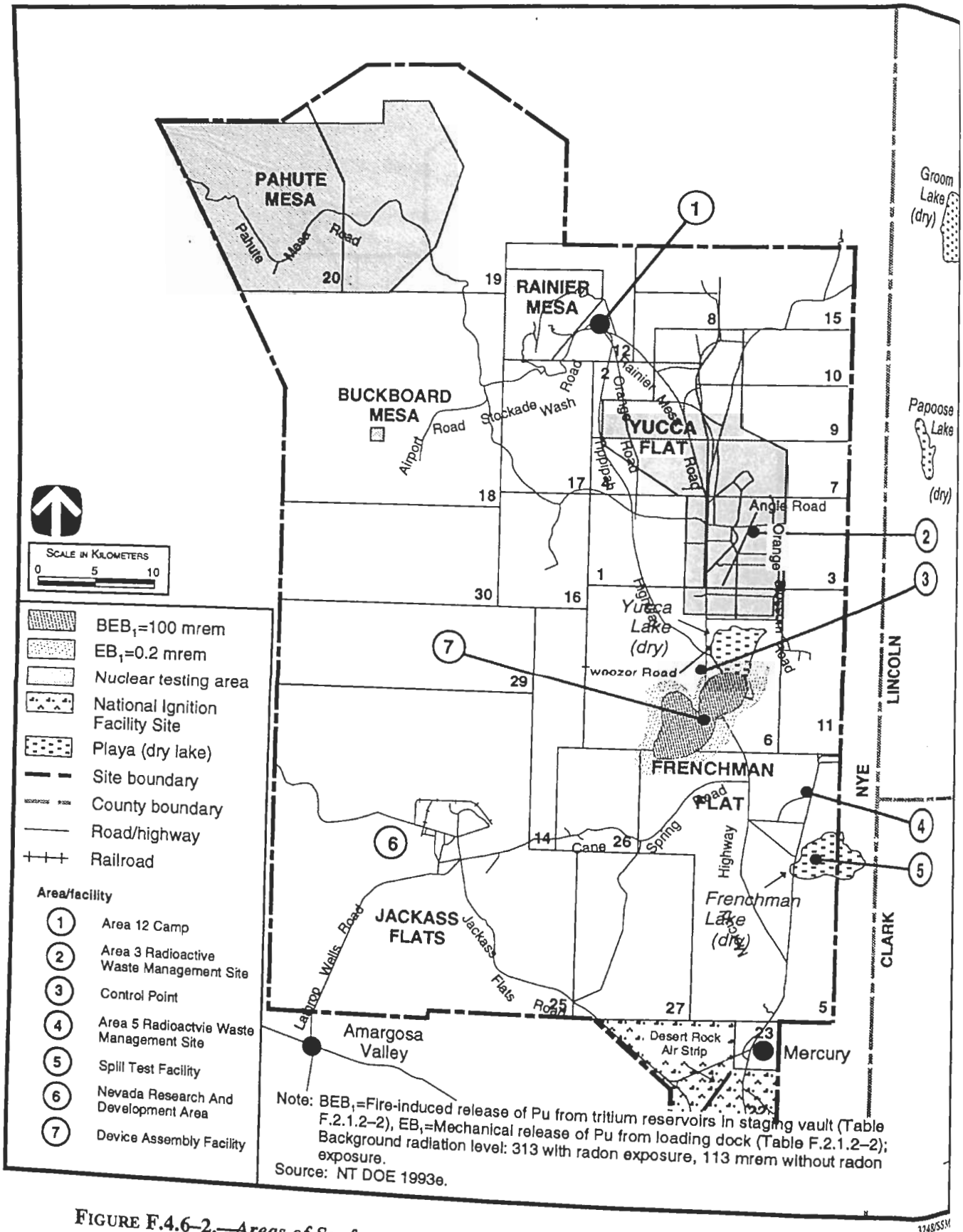


FIGURE F.4.6–2.—*Areas of Surface Exposure for Storage of Plutonium Strategic Reserve Accidents at Nevada Test Site.*

APPENDIX G

APPENDIX G: INTERSITE TRANSPORTA

G.1 TRANSPORTATION RISK ANALYSIS METHODOLOGY

The transportation risk assessment estimates the health effects, in terms of annual fatalities, from the transportation of plutonium and highly enriched uranium (HEU) for each programmatic environmental impact statement (PEIS) alternative. For this assessment, the PEIS alternatives can be described as combinations of pit fabrication, secondary and case fabrication, and assembly/disassembly (A/D) sites. The potential sites for these functions are:

- A/D—Nevada Test Site (NTS) or Pantex Plant (Pantex)
- Pit Fabrication—Los Alamos National Laboratory (LANL) or Savannah River Site (SRS)
- Secondary and Case Fabrication—LANL, Lawrence Livermore National Laboratory (LLNL), or Oak Ridge Reservation (ORR)

In addition, the sites considered for the storage of the strategic reserve of plutonium and HEU and the tritium recycling site were considered in the analysis for estimating risk. The strategic reserve of plutonium and HEU could be located at six potential sites: Hanford, Idaho National Engineering Laboratory (INEL), NTS, ORR, Pantex, or SRS. Two of these sites, NTS and Pantex, are considered by the Stockpile Stewardship and Management PEIS due to the assumption that storage of the strategic reserve in the form of pits and secondaries would be collocated at the weapons A/D sites. The other four sites are being considered by the *Storage and Disposition of Weapons-Usable Fissile Materials Draft Programmatic Environmental Impact Statement* (DOE/EIS-0229-D, February 1996) for consolidated storage of all plutonium and uranium. Tritium recycling would remain at SRS. All of the alternatives are shown in table G.1–1.

For each of the special nuclear materials and radioactive materials involved, the radiological risk calculations were performed using the RADTRAN Version 4 computer code, developed and maintained by Sandia National Laboratories (SNL) at Albuquerque, NM (*RADTRAN 4: Volume 3 Us* 2370, January 1992]).

The RADTRAN code combin demographic, transportatior material factors with health phys the expected radiological consec free and accident risk from tran material.

For performing the calculations, would be transported via Depa (DOE) safe secure trailers. Trit ported by DOE's contract air ca types and the number of pack would be in accordance with ments.

For this analysis, the isotopi assumed to be 93 percent ura shipments and 100 percent triti ments. Plutonium was assumed material.

The transport index is a regulato package and is equal to the ra millirem per hour at a distan (3.3 feet [ft]) from the outside c transport index values were e maximum allowed by regulatc rated in RADTRAN. These reg the product of the number of transport index of each package 16. The quantity of material per packages per truckload, and num year were estimated.

The transportation accident m assigns accident probabilities to egories. For the truck and air accident-severity categories de Regulatory Commission's (NRC *tal Statement on the Transport Material by Air and Other Mo* December 1977) were used. The category (Category I) represent crush force, accident-impact ve or puncture-impact speed. The i (Category VIII) represents a lar impact velocity, high punctur

TABLE G.1–1.—*Annual Health Impact from Transportation of Materials for Each Alternative* [Page 1 of 3]

Alternative	Pit Fabrication Site	Secondary and Case Fabrication Site	Plutonium Storage Site	HEU Storage Site	Tritium Recycling Site	Health Effects[a]		
						Accident	Accident-Free	Total
No Action	LANL (limited)	ORR	Pantex	ORR	SRS	2.57×10^{-3}	7.64×10^{-4}	3.33×10^{-3}
Assembly/Disassembly at NTS	LANL	ORR	NTS	ORR	SRS	4.78×10^{-3}	1.34×10^{-3}	6.12×10^{-3}
	LANL	ORR	Pantex	Pantex	SRS	6.47×10^{-3}	1.87×10^{-3}	8.34×10^{-3}
	LANL	ORR	ORR	ORR	SRS	5.30×10^{-3}	1.51×10^{-3}	6.81×10^{-3}
	LANL	ORR	NTS	NTS	SRS	8.44×10^{-3}	2.39×10^{-3}	0.0108
	LANL	ORR	SRS	SRS	SRS	6.00×10^{-3}	1.76×10^{-3}	7.76×10^{-3}
	LANL	ORR	INEL	INEL	SRS	8.76×10^{-3}	2.52×10^{-3}	0.0113
	LANL	ORR	Hanford	Hanford	SRS	9.88×10^{-3}	2.84×10^{-3}	0.0127
	SRS	ORR	NTS	ORR	SRS	7.03×10^{-3}	2.03×10^{-3}	9.06×10^{-3}
	SRS	ORR	Pantex	Pantex	SRS	8.26×10^{-3}	2.44×10^{-3}	0.0107
	SRS	ORR	ORR	ORR	SRS	5.55×10^{-3}	1.61×10^{-3}	7.16×10^{-3}
	SRS	ORR	NTS	NTS	SRS	1.07×10^{-2}	3.07×10^{-3}	0.0138
	SRS	ORR	SRS	SRS	SRS	5.87×10^{-3}	1.70×10^{-3}	7.57×10^{-3}
	SRS	ORR	INEL	INEL	SRS	1.08×10^{-2}	3.15×10^{-3}	0.0139
	SRS	ORR	Hanford	Hanford	SRS	1.19×10^{-2}	3.49×10^{-3}	0.0154
	LANL	LANL	NTS	NTS	SRS	3.87×10^{-3}	1.02×10^{-3}	4.89×10^{-3}
	LANL	LANL	Pantex	Pantex	SRS	3.06×10^{-3}	8.06×10^{-4}	3.87×10^{-3}
	LANL	LANL	ORR	ORR	SRS	5.67×10^{-3}	1.61×10^{-3}	7.28×10^{-3}
	LANL	LANL	SRS	SRS	SRS	6.39×10^{-3}	1.85×10^{-3}	8.24×10^{-3}
	LANL	LANL	INEL	INEL	SRS	4.80×10^{-3}	1.25×10^{-3}	6.05×10^{-3}
	LANL	LANL	Hanford	Hanford	SRS	5.91×10^{-3}	1.59×10^{-3}	7.50×10^{-3}
	SRS	LANL	NTS	NTS	SRS	6.13×10^{-3}	1.70×10^{-3}	7.83×10^{-3}
	SRS	LANL	Pantex	Pantex	SRS	4.84×10^{-3}	1.37×10^{-3}	6.21×10^{-3}
	SRS	LANL	ORR	ORR	SRS	5.93×10^{-3}	1.71×10^{-3}	7.64×10^{-3}
	SRS	LANL	SRS	SRS	SRS	6.23×10^{-3}	1.81×10^{-3}	8.04×10^{-3}
	SRS	LANL	INEL	INEL	SRS	6.80×10^{-3}	1.90×10^{-3}	8.70×10^{-3}
	SRS	LANL	Hanford	Hanford	SRS	7.92×10^{-3}	2.23×10^{-3}	0.0102
	LANL	LLNL	NTS	NTS	SRS	3.58×10^{-3}	1.08×10^{-3}	4.66×10^{-3}

TABLE G.1–1.—*Annual Health Impact from Transportation of Materials for Each Alternative* [Page 2 of 3]

Alternative	Pit Fabrication Site	Secondary and Case Fabrication Site	Plutonium Storage Site	HEU Storage Site	Tritium Recycling Site	Health Effects[a]		
						Accident	Accident-Free	Total
Assembly/Disassembly at NTS (Continued)	LANL	LLNL	Pantex	Pantex	SRS	4.76×10^{-3}	1.39×10^{-3}	6.15×10^{-3}
	LANL	LLNL	ORR	ORR	SRS	7.43×10^{-3}	2.21×10^{-3}	9.64×10^{-3}
	LANL	LLNL	SRS	SRS	SRS	8.16×10^{-3}	2.44×10^{-3}	0.0106
	LANL	LLNL	INEL	INEL	SRS	4.40×10^{-3}	1.25×10^{-3}	5.65×10^{-3}
	LANL	LLNL	Hanford	Hanford	SRS	4.52×10^{-3}	1.38×10^{-3}	5.90×10^{-3}
	SRS	LLNL	NTS	NTS	SRS	5.83×10^{-3}	1.77×10^{-3}	7.60×10^{-3}
	SRS	LLNL	Pantex	Pantex	SRS	6.54×10^{-3}	1.96×10^{-3}	8.50×10^{-3}
	SRS	LLNL	ORR	ORR	SRS	7.68×10^{-3}	2.32×10^{-3}	0.0100
	SRS	LLNL	SRS	SRS	SRS	8.00×10^{-3}	2.39×10^{-3}	0.0104
	SRS	LLNL	INEL	INEL	SRS	6.40×10^{-3}	1.89×10^{-3}	8.29×10^{-3}
	SRS	LLNL	Hanford	Hanford	SRS	6.53×10^{-3}	2.02×10^{-3}	8.55×10^{-3}
Assembly/Disassembly at Pantex	LANL	ORR	Pantex	ORR	SRS	2.57×10^{-3}	7.64×10^{-4}	3.33×10^{-3}
	LANL	ORR	Pantex	Pantex	SRS	4.49×10^{-3}	1.36×10^{-3}	5.85×10^{-3}
	LANL	ORR	ORR	ORR	SRS	3.32×10^{-3}	9.94×10^{-4}	4.31×10^{-3}
	LANL	ORR	NTS	NTS	SRS	6.47×10^{-3}	1.88×10^{-3}	8.34×10^{-3}
	LANL	ORR	SRS	SRS	SRS	4.03×10^{-3}	1.23×10^{-3}	5.26×10^{-3}
	LANL	ORR	INEL	INEL	SRS	6.78×10^{-3}	2.00×10^{-3}	8.78×10^{-3}
	LANL	ORR	Hanford	Hanford	SRS	7.90×10^{-3}	2.28×10^{-3}	0.0102
	SRS	ORR	Pantex	ORR	SRS	3.89×10^{-3}	1.20×10^{-3}	5.09×10^{-3}
	SRS	ORR	Pantex	Pantex	SRS	5.80×10^{-3}	1.80×10^{-3}	7.60×10^{-3}
	SRS	ORR	ORR	ORR	SRS	3.10×10^{-3}	9.67×10^{-4}	4.07×10^{-3}
	SRS	ORR	NTS	NTS	SRS	8.26×10^{-3}	2.44×10^{-3}	0.0107
	SRS	ORR	SRS	SRS	SRS	3.41×10^{-3}	1.07×10^{-3}	4.48×10^{-3}
	SRS	ORR	INEL	INEL	SRS	8.32×10^{-3}	2.52×10^{-3}	0.0108
	SRS	ORR	Hanford	Hanford	SRS	9.44×10^{-3}	2.85×10^{-3}	0.0123
	LANL	LANL	Pantex	Pantex	SRS	2.25×10^{-3}	5.96×10^{-4}	2.85×10^{-3}

TABLE G.1–1.—*Annual Health Impact from Transportation of Materials for Each Alternative* [Page 3 of 3]

Alternative	Pit Fabrication Site	Secondary and Case Fabrication Site	Plutonium Storage Site	HEU Storage Site	Tritium Recycling Site	Health Effects[a]		
						Accident	Accident-Free	Total
Assembly/Disassembly at Pantex (Continued)	LANL	LANL	ORR	ORR	SRS	4.86×10^{-3}	1.40×10^{-3}	6.26×10^{-3}
	LANL	LANL	NTS	NTS	SRS	3.06×10^{-3}	8.06×10^{-4}	3.87×10^{-3}
	LANL	LANL	SRS	SRS	SRS	5.58×10^{-3}	1.64×10^{-3}	7.22×10^{-3}
	LANL	LANL	INEL	INEL	SRS	3.98×10^{-3}	1.05×10^{-3}	5.03×10^{-3}
	LANL	LANL	Hanford	Hanford	SRS	5.10×10^{-3}	1.38×10^{-3}	6.48×10^{-3}
	SRS	LANL	Pantex	Pantex	SRS	3.57×10^{-3}	1.03×10^{-3}	4.60×10^{-3}
	SRS	LANL	ORR	ORR	SRS	4.65×10^{-3}	1.38×10^{-3}	6.03×10^{-3}
	SRS	LANL	NTS	NTS	SRS	4.84×10^{-3}	1.37×10^{-3}	6.21×10^{-3}
	SRS	LANL	SRS	SRS	SRS	4.95×10^{-3}	1.48×10^{-3}	6.43×10^{-3}
	SRS	LANL	INEL	INEL	SRS	5.52×10^{-3}	1.57×10^{-3}	7.09×10^{-3}
	SRS	LANL	Hanford	Hanford	SRS	6.64×10^{-3}	1.90×10^{-3}	8.54×10^{-3}
	LANL	LLNL	Pantex	Pantex	SRS	5.92×10^{-3}	1.71×10^{-3}	7.63×10^{-3}
	LANL	LLNL	ORR	ORR	SRS	8.59×10^{-3}	2.54×10^{-3}	0.0111
	LANL	LLNL	NTS	NTS	SRS	4.76×10^{-3}	1.39×10^{-3}	6.15×10^{-3}
	LANL	LLNL	SRS	SRS	SRS	9.33×10^{-3}	2.74×10^{-3}	0.0121
	LANL	LLNL	INEL	INEL	SRS	5.57×10^{-3}	1.56×10^{-3}	7.13×10^{-3}
	LANL	LLNL	Hanford	Hanford	SRS	5.69×10^{-3}	1.70×10^{-3}	7.39×10^{-3}
	SRS	LLNL	Pantex	Pantex	SRS	7.24×10^{-3}	2.15×10^{-3}	9.39×10^{-3}
	SRS	LLNL	ORR	ORR	SRS	8.39×10^{-3}	2.51×10^{-3}	0.0109
	SRS	LLNL	NTS	NTS	SRS	6.54×10^{-3}	1.96×10^{-3}	8.50×10^{-3}
	SRS	LLNL	SRS	SRS	SRS	8.71×10^{-3}	2.59×10^{-3}	0.0113
	SRS	LLNL	INEL	INEL	SRS	7.10×10^{-3}	2.09×10^{-3}	9.19×10^{-3}
	SRS	LLNL	Hanford	Hanford	SRS	7.23×10^{-3}	2.22×10^{-3}	9.45×10^{-3}

[a] Estimated fatalities per year.

Source: RADTRAN model results.

88-kilometer [km] per hour (54.6-mile [mi] per hour) collision into the side of the vehicle and a 982–degree Celsius (°C) (1,800–degree Fahrenheit [°F]) fire lasting 1.5 hours to produce a release of the material (plutonium, HEU, or tritium). The release fractions for Category VIII accidents were conservatively estimated to be 0.1 for all types of materials analyzed.

To perform the risk calculations, distance and distance fractions for rural, suburban, and urban populations for each intersite route were estimated using the INTERSTAT routing code. INTERSTAT is part of the RADTRAN model. Although the distance fractions in the rural, suburban, and urban populations are slightly different for each route, among the routes considered, the average distance fractions for population distribution for rural, suburban, and urban were 78, 20, and 2 percent, respectively. Also included are nonradiological impacts due to air pollution and highway accidents. Fatalities from potential air pollution were estimated using 1.0×10^{-7} cancer fatalities per urban kilometer. Highway accident fatalities were estimated from national statistics using 1.5×10^{-8} rural, 3.7×10^{-9} suburban, and 2.1×10^{-9} urban for occupational risks per kilometer, and 5.3×10^{-8} rural, 1.3×10^{-8} suburban, and 7.5×10^{-9} for nonoccupational risks per kilometer (SNL 1986a:167).

To estimate accident and accident-free impacts, the radiation dose from each shipment was converted to a risk factor by multiplying the occupational accident-free and accident dose by 4.0×10^{-4} cancers per person-rem and the public accident-free and accident dose by 5.0×10^{-4} cancers per person-rem (ICRP 1991a:22). The resultant annual health risks are presented as potential fatalities. The combined resultant health risks are presented as potential fatalities.

The estimated annual impacts for each alternative were derived by summing the health effects from individual routes. The potential sites for each alternative and the corresponding annual impacts are presented in table G.1–1.

G.2 Packaging

Packaging refers to a container and all accompanying components or materials necessary to perform its containment function. Packag
hazardous materials shipment
meet specific performance re
specifications described in De
tation (DOT) hazardous m
(49 Code of Federal Regulati
C). For relatively low-level
DOT Specification Type A
These packagings are desi
contents under normal trans
More sensitive radioactive
require use of highly sophisti
ing, designed and tested to
contents under all credible t
conditions.

Plutonium, HEU, and compon
are DOE-unique hazardous
special protection. In add
stringent Type B containm
requirements of NRC's 10
49 CFR, packaging for nuclea
nents must be certified sepa
employs a closed, Governmer
Transportation Safeguards S
transport of nuclear weapc
including plutonium and HE
safe secure trailers are utilize
of safety and physical protect
ponents are transported almos
contract air carrier.

As a representation of a typi
used to transport weapons cc
sequence for the 6M, Type B
shipment of HEU is described
tritium packaging requires a
protection. Most other radic
materials, such as low-level
ported by commercial truck. F
the hazardous and nonhazardo
and from each of the candidat
tables G.3–1, G.3–2, and G.3-

In addition to meeting standar
withstand normal conditions o
or dispersal of its radioactiv
6M, Type B packaging used fc
survive certain severe hypoth
tions that demonstrate resistan
fire, and water submersion.

duplicate accident environments but, rather, produce damage equivalent to extreme and unlikely accidents. The 6M, Type B packaging is judged as surviving extreme sequential testing if it retains all of its contents except for minuscule allowable releases, and if the dose rate outside the packaging does not exceed 1 rem/hour at a distance of 1 m from the package surface. Drum sizes (outer package) can vary from 38 to 420 liters (10 to 110 gallons).

The complete sequence of tests is listed below:

- **Drop Test.** A 9-m (30-ft) drop onto a flat, essentially unyielding, horizontal surface, striking the surface in a position at which maximum damage is expected

- **Puncture Test:** A 1-m (40-inch [in]) drop onto the upper end of a 15-centimeter (cm) (6-in) diameter solid, vertical, cylindrical, mild steel bar mounted on an essentially unyielding, horizontal surface

- **Thermal Test:** An exposure for not less than 30 minutes to a heat flux not less than that of a radiation environment of 800 °C (1,475 °F) with an emissivity coefficient of at least 0.9

- **Water-Immersion Test:** A subjection to water pressure equivalent to immersion under a head of water of at least 15 m (50 ft) for not less than 8 hours

The regulatory test conditions for the 6M, Type B packaging and other similar packagings are much more demanding than they might appear. For example, an impact on a very hard surface (desert caliche) at over 32 km (200 mi) per h likely to deform the packaging as wou 9 m (30 ft) onto an unyielding target.

The 6M, Type B packaging is made u component parts each playing an integra role in containment and confinement of th material being shipped. The applicable Analysis Report for Packaging provide detail that shows that the package provides of public safety regardless of the accidenta it might encounter during transportation 6M, Type B packaging approved for use covered by a Certificate of Compliance. 6M, Type B packagings have been involv accidents, the integrity of the packaging been compromised. A representative 6M p shown in figure G.2–1.

G.3 Intersite Shipment Data

Table G.3–1 presents a 5-year (1990 thro summary of the nonhazardous and hazard shipped by commercial carriers to and fro the candidate sites.

Table G.3–2 presents a summary, by chemi of hazardous materials shipped to and fro City Plant (KCP), LANL, LLNL, and NTS Table G.3–3 presents a summary, by chemi of hazardous materials shipped to and fr Pantex, SNL, and SRS in 1994. All refe SNL refer to the Albuquerque location.

G.4 Highway Distance

Table G.4–1 presents highway distances sites being evaluated.

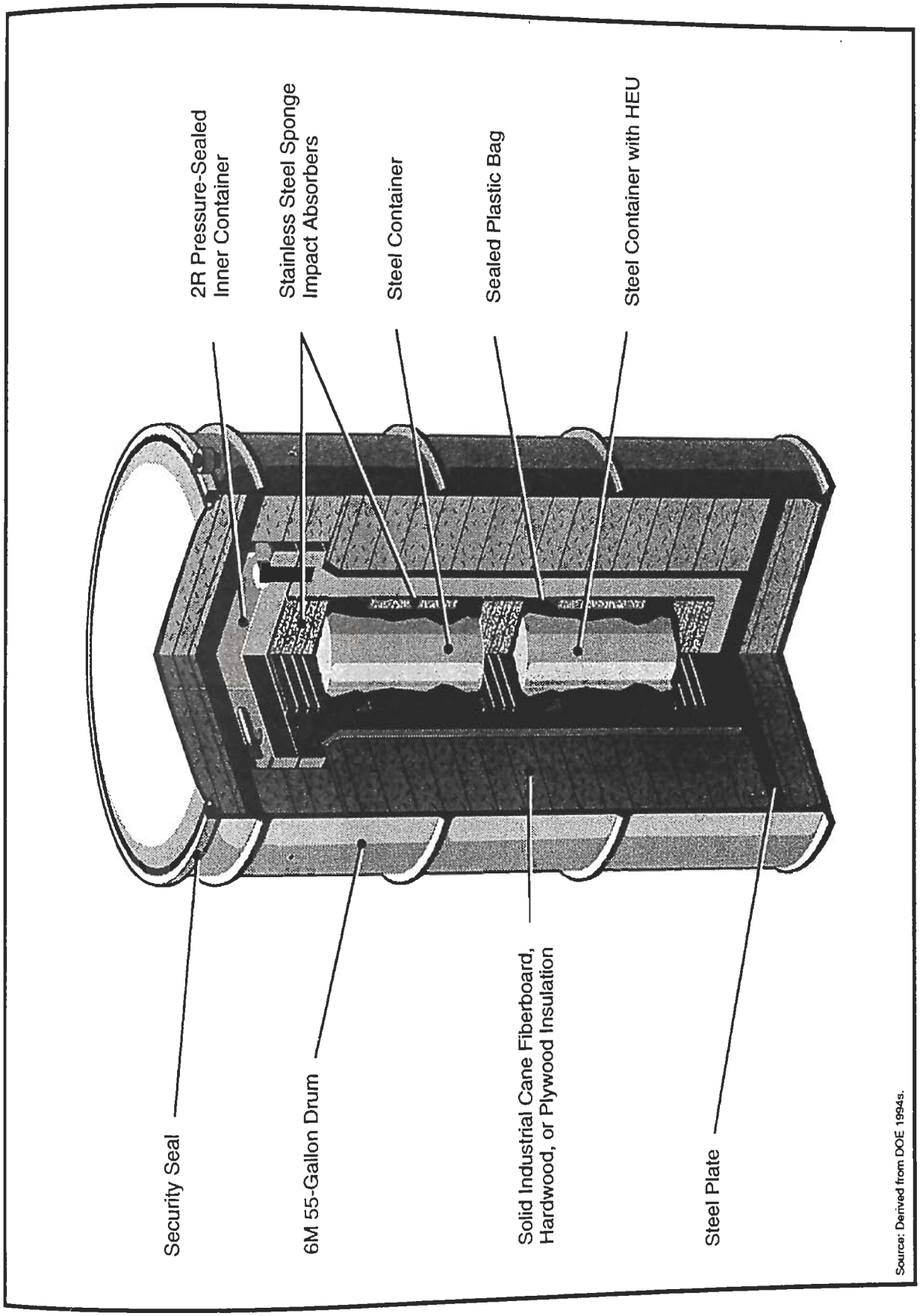


FIGURE G.2-1.—*A Representative 6M Packaging Array.*

TABLE G.3–1.—*Five-Year Summary of Cargo Shipments by Commercial Carrier to and from Candidate Sites* [Page 1 of 2]

Site	1990		1991		1992		1993		1994	
	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)
Kansas City Plant										
Hazardous	800	363,943	350	142,510	455	142,155	668	170,716	389	120,481
Nonhazardous	18,774	1,933,747	13,680	1,704,409	14,530	1,169,727	13,354	1,040,980	9,998	877,005
All cargo	19,574	2,297,690	14,030	1,846,919	14,985	1,311,882	14,022	1,211,696	10,387	997,486
Los Alamos National Laboratory										
Hazardous	851	544,668	680	316,974	1,089	363,818	1,133	345,403	692	214,510
Nonhazardous	28,266	4,129,802	28,757	3,943,075	36,805	1,855,129	46,663	2,617,906	49,453	3,327,743
All cargo	29,117	4,674,470	29,437	4,260,049	37,894	2,218,947	47,796	2,963,309	50,145	3,542,253
Lawrence Livermore National Laboratory										
Hazardous	987	931,582	453	277,618	2,264	3,329,414	4,510	11,785,251	5,089	15,944,718
Nonhazardous	5,080	729,180	78	455,632	39,818	3,161,580	50,902	4,397,530	56,037	4,243,668
All cargo	6,067	1,660,762	531	733,250	42,082	6,490,994	55,412	16,182,781	61,126	20,188,386
Nevada Test Site										
Hazardous	1,742	20,627,008	1,325	15,777,433	1,432	17,834,469	1,143	15,845,750	1,324	22,384,272
Nonhazardous	23,107	38,455,253	21,898	36,197,342	19,938	31,944,034	16,568	10,622,714	14,839	21,567,339
All cargo	24,849	59,082,261	23,223	51,974,775	21,370	49,778,503	17,711	26,468,464	16,163	43,951,611
Oak Ridge Reservation										
Hazardous	2,141	3,592,513	1,433	2,254,290	3,896	8,546,187	3,130	11,765,312	3,169	6,438,748
Nonhazardous	55,921	8,176,837	57,217	6,905,370	69,771	7,448,941	74,479	5,409,370	75,684	7,409,628
All cargo	58,062	11,769,350	58,650	9,159,660	73,667	15,995,128	77,609	17,174,682	78,853	13,848,376
Pantex Plant										
Hazardous	1,869	407,622	1,339	462,842	1,124	601,087	1,080	597,720	612	328,329
Nonhazardous	8,494	1,262,617	10,085	1,314,989	10,191	1,317,023	11,135	1,733,062	11,760	1,732,379
All cargo	10,363	1,670,239	11,424	1,777,831	11,315	1,918,110	12,215	2,330,782	12,372	2,060,708
Sandia National Laboratories										
Hazardous	454	114,870	482	120,977	554	124,924	456	45,101	695	414,554
Nonhazardous	20,653	2,944,455	20,018	2,254,413	26,986	2,850,913	34,136	3,159,762	39,315	3,624,333
All cargo	21,107	3,059,325	20,500	2,375,390	27,540	2,975,837	34,592	3,204,863	40,010	4,038,887

TABLE G.3–1.—*Five-Year Summary of Cargo Shipments by Commercial Carrier to and from Candidate Sites* [Page 2 of 2]

Site	1990		1991		1992		1993		1994	
	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)
Savannah River Site										
Hazardous	1,151	4,049,534	643	3,192,682	1,462	2,625,821	1,386	2,508,277	1,147	2,754,435
Nonhazardous	36,012	227,513,797	33,870	151,211,460	34,348	136,905,940	34,816	224,005,944	25,915	241,279,894
All cargo	37,163	231,563,331	34,513	154,404,142	35,810	139,531,761	36,202	226,514,221	27,062	244,034,329

Note: Gross weights, which include the weight of the package.

Source: SAIC 1995a:1.

TABLE G.3–2.—*Summary of Hazardous Materials Shipped to and from Kansas City Plant, Los Alamos National Laboratory, Lawrence Livermore National Laboratory, and Nevada Test Site, 1994* [Page 1 of 5]

Commodity	KCP		LANL		LLNL		NTS	
	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)
Acetylene gas			1	95	45	15,812		
Aluminum nitrate							2	144
Aluminum sulfate, solid	1	295	1	142				
Ammonia, anhydrous			1	41	17	3,635	1	1,487
Ammonium fluoride					1	5		
Ammonium hydroxide					18	262		
Ammonium sulfate					3	19	1	13
Argon			3	354	431	1,619,450	20	5,975
Asbestos articles			1	1	10	79,565		
Asphalt					3	68	6	3,288,218
Beryllium metal			1	3				
Beryllium metal or powder					11	66		
Cadmium nitrate								
Cadmium sulfate								
Calcium nitrate					1	5		
Chlorine			1	3	12	381	1	5,670
Class A poison			3	18			2	296

TABLE G.3–2.—*Summary of Hazardous Materials Shipped to and from Kansas City Plant, Los Alamos National Laboratory, Lawrence Livermore National Laboratory, and Nevada Test Site, 1994* [Page 2 of 5]

Commodity	KCP		LANL		LLNL		NTS	
	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)
Class B poison	5	2,888						
Combustible liquid, n.o.s.	8	1,996	6	1,529	31	7,382	10	55,477
Corrosive material, n.o.s.	108	50,584	28	2,458	208	17,579	29	6,205
Dry ice	9	879	49	427	175	95,059		
Empty haz containers (non-radiological)					2	617	76	292,447
Enriched boric acid								
Environmentally hazardous substance (marine pollutant)							1	5,443
Environmentally hazardous substance	1	17			17	4,458		
Etiologic agent, n.o.s.								
Explosives, n.o.s. (Class 1.1)			1	4				
Explosives, n.o.s. (Class 1.2)	2	349	8	426	63	2,670	3	4,891
Explosives, n.o.s. (Class 1.3)								
Explosives, n.o.s. (Class 1.4)					22	3,805		
Ferrous sulfamate	53	8,119	7	376	89	5,317		
Ferrous sulfate							1	5
Flammable gas, n.o.s.			43	35,757	170	127,807	3	178
Flammable liquid, n.o.s.	64	21,712	23	4,162	198	12,861	21	2,169
Flammable solid, n.o.s.	56	7,414	14	285	21	2,180	2	214
Fluoboric acid					1	5		
Fuel oil (diesel, 1-6)			5	7,146	28	153,493	122	4,093,274
Gasoline			1	2	43	917,622	94	2,741,403
Hazardous waste (nonradiological)	1	408	1	66	269	821,224	2	12
Helium			27	18,439	646	704,382	5	1,278
Hydrocarbon gas, compressed or liquefied								

Hydrofluoric acid			2	2,169	49 32	869 358	5 3	724 633

TABLE G.3–2.—*Summary of Hazardous Materials Shipped to and from Kansas City Plant, Los Alamos National Laboratory, Lawrence Livermore National Laboratory, and Nevada Test Site, 1994* [Page 3 of 5]

	KCP		LANL		LLNL		NTS	
Commodity	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)
Hydrofluoric acid solution, spent			1	1			3	74
Hydrogen gas			1	33	95	152,076		
Hydrogen peroxide					50	23,105	2	343
Irritant, n.o.s.			2	2				
Isobutane, compressed or liquefied			2	1,134	1	64	1	3
Lithium metal	3	249	3	5	18	839		
Lubricating oil			2	182	43	4,746	33	31,307
Magnesium, powder, metal strip			2	11	12	450		
Mercuric nitrate			1	15	1	2	1	1
Methanol, liquid					33	1,163	1	40
Methyl isobutyl ketone					4	309	7	150,547
Misc. hazardous material					10	13,357		
N-dodecane					1	45		
Natural gas, compressed or liquefied							1	1,270
Nitric acid, fuming	4	602	1	1	70	1,586	5	1,098
Nitric acid (over 40 percent)							1	334
Nitric acid, fuming								
Nitrogen			8	277	877	9,990,231	20	14,370
Nonflammable gas, n.o.s.	16	5,909	91	28,603	484	429,841	25	16,682

TABLE G.3–2.—*Summary of Hazardous Materials Shipped to and from Kansas City Plant, Los Alamos National Laboratory, Lawrence Livermore National Laboratory, and Nevada Test Site, 1994* [Page 4 of 5]

Commodity	KCP		LANL		LLNL		NTS	
	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)
Poison, liquid, n.o.s.	24	2,780	9	1,026	36	1,761		
Poison, solid, n.o.s.	9	2,483	7	98	21	379	1	19
Propane, compressed or liquefied			1	272			2	158
RAM, empty packages			49	35,462	23	8,294	1	1,016
RAM, fissile, <20 percent uranium-235								
RAM, fissile, >20 percent uranium-235								
RAM, fissile, HRCQ								
RAM, fissile, HRCQ, IR								
RAM, fissile, HRCQ, UNIR								
RAM, fissile, n.o.s.			10	669	1	110		
RAM, fissile, UNIR								
RAM, fissile, waste								
RAM, HRCQ, special								
RAM, instruments and articles			1	154	12	5,856		
RAM, low-specific activity, n.o.s.			5	4,651	141	117,718		
RAM, low-specific activity, uranium hexafluoride			1	277				
RAM, low-specific activity, waste					18	258,967	688	11,291,791
RAM, limited quantity, n.o.s.	2	18	124	3,257	89	9,739	3	3,570
RAM, medical isotopes			6	31				
RAM, n.o.s.			75	21,660	53	33,296	25	2,170
RAM, n.o.s., HRCQ			1	16,329	2	2,386		
RAM, n.o.s., special			5	3,889	2	356	8	5,708
RAM, n.o.s., waste					9	126,634		
RAM, uranium-metal, pyrop			1	1	3	402		
RAM, uranium oxide, n.o.s.					1	204		

TABLE G.3–2.—*Summary of Hazardous Materials Shipped to and from Kansas City Plant, Los Alamos National Laboratory, Lawrence Livermore National Laboratory, and Nevada Test Site, 1994* [Page 5 of 5]

Commodity	KCP		LANL		LLNL		NTS	
	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)
Small arms ammunition					3	74	1	387
Sodium hydroxide (caustic soda)			7	8,218	47	5,986	7	8,389
Sodium metal (non-RAM)					5	16		
Sodium nitrate			1	5	5	26	1	3
Spontaneously combustible material	1	54	3	47	12	90		
Sulfuric acid			2	403	35	3,386	1	1
Toxic gas, inhalation hazard	1	54	26	7,500	72	7,379		
Trichloroethane 1,1,1					5	396		
Wet cell batteries	1	53	9	2,013	13	15,775	64	344,251
Total	391	120,831	692	214,512	5,089	15,944,719	1,324	22,384,275

Note: Gross weights, which include the weight of the package. RAM - radioactive material; HRCQ - highway route controlled quantity; IR - irradiated; UNIR - unirradiated; n.o.s. - not otherwise specified.

Source: SAIC 1995a:2.

TABLE G.3–3.—*Summary of Hazardous Materials Shipped to and from Oak Ridge Reservation, Pantex Plant, Sandia National Laboratories, and Savannah River Site, 1994* [Page 1 of 5]

Commodity	ORR		Pantex		SNL		SRS	
	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)
Acetylene gas	13	8,101					17	3,372
Aluminum nitrate	1	5					2	53
Aluminum sulfate, solid	1	378					2	6,277
Ammonia, anhydrous	3	686			1	7	4	587
Ammonium fluoride	1	1						
Ammonium hydroxide			1	34				
Ammonium sulfate								
Argon	199	430,223	8	1,250	1	6	33	82,713
Asbestos articles	33	37,544						

TABLE G.3–3.—*Summary of Hazardous Materials Shipped to and from Oak Ridge Reservation, Pantex Plant, Sandia National Laboratories, and Savannah River Site, 1994* [Page 2 of 5]

Commodity	ORR		Pantex		SNL		SRS	
	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)
Asphalt			1	540				
Beryllium metal								
Beryllium metal or powder	1	6,638						
Cadmium nitrate	1	489						
Cadmium sulfate								
Calcium nitrate	1	1	1	2				
Chlorine	35	63,200	4	1,780				
Class A poison	2	10			7	1,919		
Class B poison	2	3,680	2	1,343	2	60		
Combustible liquid, n.o.s.	28	2,237	7	1,142	1	4	3	119
Corrosive material, n.o.s.	183	213,634	60	15,996	94	26,185	120	290,507
Dry ice	153	45,406			2	511		
Empty haz containers (non-radiological)	210	576,434			1	752		
Enriched boric acid								
Environmentally hazardous substance (marine pollutant)	3	80					1	20
Environmentally hazardous substance	10	4,934						
Etiologic agent, n.o.s.	1	144						
Explosives, n.o.s. (Class 1.1)			27	25,058	26	41,891		
Explosives, n.o.s. (Class 1.2)			1	40	5	29,821		
Explosives, n.o.s. (Class 1.3)			2	2,650	27	259,008		
Explosives, n.o.s. (Class 1.4)	7	3,870	93	14,008	28	2,064	8	4,859
Ferrous sulfamate	1	2,749	1	21				
Ferrous sulfate	2	2,041						
Flammable gas, n.o.s.	42	24,301	13	1,734	9	372	25	57,028
Flammable liquid, n.o.s.	140	54,056	54	6,947	48	3,352	33	28,406
Flammable solid, n.o.s.	35	360	58	6,068	9	1,222	1	7

TABLE G.3–3.—*Summary of Hazardous Materials Shipped to and from Oak Ridge Reservation, Pantex Plant, Sandia National Laboratories, and Savannah River Site, 1994* [Page 3 of 5]

Commodity	ORR		Pantex		SNL		SRS	
	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)
Fluoboric acid	1	1						
Fuel oil (diesel, 1-6)	109	366,209					3	2,188
Gasoline	166	624,837					10	4,790
Hazardous waste (nonradiological)	3	12	1	19			8	1,438
Helium	33	42,913	11	640	157	33,864	21	27,444
Hydrocarbon gas, compressed or liquefied								
Hydrochloric acid	16	95	6	20			25	43,606
Hydrofluoric acid	2	59					7	6,885
Hydrofluoric acid solution, spent	1	4					1	27
Hydrogen gas	11	39,032	3	217			13	2,620
Hydrogen peroxide	8	1,911	1	2			9	3,870
Irritant, n.o.s.								
Isobutane, compressed or liquefied	2	1						
Lithium metal	24	3,290	9	845	2	10		
Lubricating oil	13	1,589	14	3,766			22	8,391
Magnesium, powder, metal strip	10	6					1	39
Mercuric nitrate								
Methanol, liquid	1	1					1	123
Methyl isobutylketone								
Misc. hazardous material	19	653	1	13	1	114	1	75
N-dodecane								
Natural gas, compressed or liquefied							1	373
Nitric acid fuming	14	20,827	3	59			22	6,270
Nitric acid (over 40 percent)	1	18					4	306
Nitric acid, fuming	1	2					3	1,143

TABLE G.3–3.—*Summary of Hazardous Materials Shipped to and from Oak Ridge Reservation, Pantex Plant, Sandia National Laboratories, and Savannah River Site, 1994* [Page 4 of 5]

Commodity	ORR		Pantex		SNL		SRS	
	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)
Nitrogen	58	269,550	2	384	1	8	32	69,318
Nonflammable gas, n.o.s.	141	103,053	29	6,310	18	2,649	205	1,477,767
Organic peroxide, n.o.s.	2	2					2	11
Orm A, n.o.s.	2	7,874						
Orm B, n.o.s.								
Orm D, consumer commodity							10	4,619
Orm E, n.o.s.	5	11,544						
Other regulated material, liquid	3	79					1	626
Other regulated material, solid	1	159						
Oxidizer, n.o.s.	47	1,486	2	35	2	49	4	15,321
Oxygen	24	4,811	2	258			20	26,036
Poison, liquid, n.o.s.	47	5,880	4	124	10	231	1	1
Poison, solid, n.o.s.	50	258			19	47	1	1
Propane, compressed or liquefied	5	227					1	68
RAM, empty packages	68	313,080	88	159,735			17	24,540
RAM, fissile, <20 percent uranium-235	3	6,275						
RAM, fissile, >20 percent uranium-235	15	2,318						
RAM, fissile, HRCQ								
RAM, fissile, HRCQ, IR, PINS							17	212,305
RAM fissile, HRCQ, UNIR, PINS								
RAM, fissile, n.o.s.	10	36,770	1	1,659	1	195	2	220
RAM, fissile, UNIR, PINS								
RAM, fissile, waste			1	7,254				
RAM, HRCQ, special	2	4,364						
RAM, instr. and articles	9	5,875	5	91				

TABLE G-3–3.—*Summary of Hazardous Materials Shipped to and from Oak Ridge Reservation, Pantex Plant, Sandia National Laboratories, and Savannah River Site, 1994* [Page 5 of 5]

Commodity	ORR		Pantex		SNL		SRS	
	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)	Shipments (number)	Weight (kg)
RAM, LSA, n.o.s.	454	1,120,758	9	465				
RAM, LSA, UF_6	66	1,270,833						
RAM, LSA, waste	6	111,223						
RAM, ltd. quant., n.o.s.	209	197,911	48	57,469	107	8,176	239	64,891
RAM, medical isotopes	107	390						
RAM, n.o.s.	135	124,546	23	3,903	107	302	32	69,099
RAM, n.o.s., HRCQ	1	13,744						
RAM, n.o.s., special	58	38,376	6	89			6	216
RAM, n.o.s., waste	1	109						
RAM, U-metal, pyrop	3	529			1	11		
RAM, UO_x, n.o.s.	1	2						
Small arms ammunition	1	1,013	4	4,913	2	1,237		
Sodium hydroxide (caustic soda)	27	70,840			1	134	52	39.585
Sodium metal, (non-RAM)	3	65			1	136		
Sodium nitrate	3	233	1	2			3	169
Spontaneously combustible material	1	3			1	6		
Sulfuric acid	13	103,875			3	211	13	81,353
Toxic gas, inhalation hazard	16	340	1	653			7	1,675
Trichloroethane 1.1.1	8	247	2	108				
Wet cell batteries	21	27,448	2	684			81	83,084
Total	3,169	6,438,748	612	328,329	695	414,553	1,147	2,754,435

Note: Gross weights, which include the weight of the package. n.o.s. - not otherwise specified; RAM - radioactive material.
Source: SAIC 1995a:2.

TABLE G.4–1.—*Highway Distances Between Selected Sites in Kilometers (Miles)*

Site	SRS	SNL	Pantex	ORR	NTS	LANL	LLNL
KCP	1,599 (993)	1,259 (782)	869 (540)	1,153 (716)	2,330 (1,447)	1,293 (803)	2,919 (1,832)
LLNL	4,249 (2,639)	1,713 (1,064)	2,178 (1,353)	3,911 (2,429)	958 (595)	1,860 (1,155)	
LANL	2,605 (1,618)	166 (103)	535 (332)	2,267 (1,408)	1,220 (758)		
NTS	3,610 (2,242)	1,074 (667)	1,539 (956)	3,272 (2,032)			
ORR	531 (330)	2,145 (1,369)	1,732 (1,076)				
Pantex	2,070 (1,286)	472 (293)					
SNL	2,542 (1,579)						

Source: DOE 1991j; DOE 1992o:3; McNally 1990a.

APPE

Appendix II

APPENDIX H: ENVIRONMENTAL MANAG

H.1 OVERVIEW

This appendix provides a general overview of the Department of Energy (DOE) Environmental Restoration and Waste Management Program, including the categories of waste streams managed by DOE; the applicable Federal statutes and DOE orders; waste minimization and pollution prevention; waste treatment, storage, and disposal; transportation of wastes; and facility transition management. Site-specific discussions of current waste management activities will follow in section H.2. Stockpile management project-specific waste management activities are addressed in appendix section A.3. Stockpile stewardship project-specific waste management activities are addressed in appendix I (National Ignition Facility [NIF]), appendix J (Contained Firing Facility [CFF]), and appendix K (Atlas Facility).

H.1.1 Waste Categories

Wastes are generated in gaseous, liquid, and solid forms and are categorized by their health hazard and handling requirements. The categories are listed in table H.1.1–1.

H.1.2 Applicable Federal Statutes and Department of Energy Orders

Most of the regulations that impact the storage, treatment, and disposal of wastes were promulgated since the original Nuclear Weapons Complex (Complex) was established. In many cases, the technology available at the time the Complex was constructed does not meet current requirements for full compliance and, as a result, interim agreements have been made with the regulatory agencies. Through continuous upgrade programs, processes have been improved or added to meet the requirements of any new regulations. Operations continue on the basis of using "best available technology" for facilities that were in operation before the regulation came into effect. In the siting and construction of any new facilities, the intent is to meet current regulations and to reach the goal of maximum recycling, minimal waste generation, no liquid discharges to the surface, and treatment and stabilization of unavoidable wastes sufficient for long-term storage or permanent disposal either on or offsite.

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milestones are renegotiated or
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The following section summ
Federal statutes and DOE orde

Atomic Energy Act. The *Atc*
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TABLE H.1.1–1.—*Waste Categories*

Category	Characterization
Spent nuclear fuel	Nuclear reactor fuel that has been irradiated to the extent that it has undergone significant isotopic change to the point that fission-product poisons have reached an uneconomic threshold. DOE is no longer reprocessing spent nuclear fuel solely to recover fissile and fertile material. Although spent nuclear fuel is not categorized as a nuclear waste, the definition is provided here since it is radioactive material that must be stored, managed, and handled.
High-level	Highly radioactive material that results from the reprocessing of spent nuclear fuel including liquid waste produced directly in reprocessing, and any solid waste derived from the liquid that contains fission products in sufficient concentrations and other highly radioactive material that the NRC, consistent with existing law, determines to require permanent isolation.
Transuranic	Radioactive waste contaminated with alpha-emitting elements with an atomic number greater than uranium, half-life greater than 20 years, and in concentrations greater than 100 nanocuries per gram (nCi/g). Such wastes result primarily from fuel reprocessing, and from the fabrication of plutonium weapons components and plutonium-bearing reactor fuel. Generally, little or no shielding is required ("contact-handled" transuranic waste), but energetic gamma and neutron emissions from certain transuranic nuclides and fission-product contaminants may require shielding or remote handling ("remote-handled" transuranic waste).
Low-level	Radioactive waste that is not spent nuclear fuel, high-level waste (HLW), transuranic (TRU) waste, or byproduct material as defined by DOE Order 5820.2A, *Radioactive Waste Management.* Includes research and development (R&D) fissionable test specimens with TRU less than 100 nCi/g. The radiation level from this waste may sometimes be high enough to require shielding for handling and transport. In 10 CFR 61, NRC defines four disposal categories of low-level waste (LLW) that require differing degrees of confinement and/or monitoring: classes A, B, C, and Greater-Than-Class C.
Hazardous	Nonradioactive waste that has characteristics identified by either or both of the following Federal statutes: *The Resource Conservation and Recovery Act* (RCRA) (40 CFR 261) as amended or the *Toxic Substances Control Act* (TSCA). These toxic, corrosive, reactive, or ignitable substances and RCRA-listed wastes have been identified as posing health or environmental risks. Hazardous waste includes chemicals (such as chlorinated and nonchlorinated hydrocarbons), explosives, leaded oil, paint solvents, sludges, acids, organic solvents, heavy metals, and pesticides.
Mixed	Waste containing both hazardous and radioactive constituents.
Nonhazardous (Sanitary)	Solid sanitary waste that includes garbage, is routinely generated by normal housekeeping activities and does not have a defined health risk (neither radioactive nor hazardous). Solid sanitary waste is regulated under RCRA, Subtitle D. Liquid sanitary waste includes sewage and industrial waste, and is treated in a wastewater process before discharge to a publicly owned treatment works or surface waters. The management of liquid sanitary waste is regulated by the *Clean Water Act* (CWA) and the National Pollutant Discharge Elimination System (NPDES).
Nonhazardous (Other)	Other wastes that do not have a defined health risk, such as process wastewater.

Resource Conservation and Recovery Act. The *Resource Conservation and Recovery Act* (RCRA) was passed in 1976 as an amendment to the *Solid Waste Disposal Act* of 1965. RCRA regulates the "cradle to grave" management (generation, accumulation, storage, treatment, recycling, transport, and disposal) of hazardous waste, nonhazardous waste, underground storage tanks containing petroleum products and hazardous substances, and medical waste. Subtitle C of RCRA mandates that hazardous wastes be treated, stored, and disposed of in a manner that will minimize the threat to human health and the environment. To carry out this mandate, RCRA requires that owners and operators of hazardous waste treatment, storage, and disposal facilities obtain operating or post-closure care permits for certain waste management activities. RCRA defines the requirements for treatment, storage, and disposal facilities. Subtitle D of the law addresses the management of nonhazardous solid waste. Title 40 of the *Code of Federal Regulations* (CFR) implements the statutory provisions of RCRA. RCRA is a program

which may be delegated to the states and for most states where DOE facilities are located, such delegation has occurred.

Land Disposal Restrictions. The *Hazardous and Solid Waste Amendments* to RCRA enacted in 1984 required the EPA to evaluate all listed and characteristic hazardous wastes according to a strict schedule and to develop requirements by which disposal of these wastes would be protective of human health and the environment. The implementing regulations for accomplishing this statutory requirement are established with the Land Disposal Restrictions Program. The land disposal restrictions regulations (40 CFR 268) impose significant requirements on waste management operations and environmental restoration activities. For hazardous wastes restricted by statute from land disposal, EPA is required to set levels or methods of treatment that substantially reduce the waste's toxicity or the likelihood that the waste's hazardous constituents will migrate. After the land disposal restriction's effective date, restricted wastes that do not meet treatment standards are prohibited from land disposal unless they qualify for certain variances or exemptions. EPA has promulgated standards for each of the five statutorily designated categories (40 CFR 268.31–40 CFR 268.35).

In addition to prohibiting disposal before appropriate treatment, land disposal restrictions prohibit any storage of land-disposal-restricted hazardous wastes (including mixed waste) except "for the purpose of the accumulation of such quantities of hazardous waste as are necessary to facilitate proper recovery, treatment, or disposal" (40 CFR 268.50). EPA has determined that storage of a hazardous waste pending development of treatment capacity does not constitute storage to accumulate sufficient quantities to "facilitate proper recovery, treatment, or disposal."

Underground Storage Tank Provisions. The requirements for the facilities that use tank systems for storing or treating hazardous waste are outlined in 40 CFR 264, Subpart J. These requirements include assessment of the existing tank system's integrity, design, and installation of new tank systems or components, and secondary containment. Hazardous wastes or treatment reagents are not placed in a tank system if they could cause the tank, its ancillary equipment, or the containment system to rupture, leak, corrode, or otherwise fail. Controls and practices to prevent spills and overflows from tank or containment systems are also required. Inspection requirements, procedures for response to leaks or spills, the disposition of leaking or unfit-for-use tanks, and closure and post-closure care requirements are also outlined in 40 CFR 264, Subpart J. Ignitable or reactive and incompatible hazardous wastes have special requirements.

Resource Conservation and Recovery Act Corrective Action Program. Hazardous waste permits require sites to institute corrective action programs for investigating and remediating Solid Waste Management Units. This program applies to all operating, closed, or closing RCRA facilities.

Federal Facility Compliance Act. The *Federal Facility Compliance Act* was passed in 1992. It waived sovereign immunity for Federal facilities and included provisions concerning DOE compliance with RCRA hazardous waste treatment for mixed waste. The *Federal Facility Compliance Act* required DOE to have approved site-specific mixed waste treatment plans and related orders in place 3 years (October 1995) from the date of enactment in order to avoid the imposition of fines and penalties (except for sites already subject to a permit, agreement, or order addressing compliance with the RCRA land disposal restrictions storage prohibition).

In an April 6, 1993, *Federal Register* notice (58 FR 17875), DOE published its schedule for submitting plans for treating mixed wastes for each facility at which DOE generates or stores mixed waste. Two interim versions of the plans were used to facilitate discussions among states and other interested parties. A subsequent consent order signed by the regulatory agency requires implementation of the final site treatment plan. For mixed waste for which identified treatment technologies exist, the plans provide a schedule for submitting permit applications, entering into contracts, initiating construction, conducting systems testing, starting operation, and processing mixed wastes. For mixed waste without an identified treatment technology, the plans include a schedule for identifying and developing technologies, identifying the funding requirements for research and development (R&D), submitting treatability study exemptions, and submitting R&D permit applications. In cases where DOE proposes radionuclide separation, the plans also provide an estimate of the volume of waste that would exist without such sepa-

ration as well as cost estimates and underlying assumptions. DOE also prepared summary documents of the final plans to provide a national picture of DOE's technology needs and possible options for treatment of its mixed waste. The summaries were provided to all states and made available to other interested parties.

Comprehensive Environmental Response, Compensation, and Liability Act. The *Comprehensive Environmental Response, Compensation, and Liability Act* (CERCLA), as amended by the *Superfund Amendments and Reauthorization Act* (SARA) of 1986, provides liability, compensation, cleanup, and emergency response for hazardous substances (including radionuclides) released to the environment. The cleanup of inactive waste disposal sites is one of the major requirements of CERCLA. It provides for prioritization of cleanup actions (National Priorities List [NPL] or Superfund List) and directs that a Federal Facility Compliance Agreement be negotiated with EPA and the state to coordinate CERCLA and RCRA compliance activities in one comprehensive strategy for each Federal facility. CERCLA also requires public participation in the selection of remediation alternatives, and this involvement or participation usually addresses the requirements of CERCLA, RCRA, and the *National Environmental Policy Act* (NEPA). Title III of CERCLA further requires that the National Response Center (operated by the U.S. Coast Guard) be notified in the event that a nonpermitted release of a reportable quantity of hazardous substance or radionuclides occurs. In the case of such a release, the National Response Center alerts the appropriate Federal emergency personnel who assess the event, formulate a response, and notify cognizant local emergency agencies. SARA requires industries to report the hazardous substances used at their facilities to include reporting inventories of these substances.

National Contingency Plan. The National Contingency Plan is an implementation regulation that sets forth requirements necessary to comply with CERCLA and SARA. For every site that is targeted for remedial response action under Section 104 of CERCLA, the National Contingency Plan requires that a detailed remedial investigation/feasibility study be conducted. The remedial investigation emphasizes data collection and site characterization. Its purpose is to define the nature, extent, and significance of contamination at a site in orde select, and design a cost-effective rem The feasibility study emphasizes analys decision making; it uses results from investigation to develop response ob alternative remedial responses. These are then evaluated in terms of their eng sibility, public health protection, en impacts, and costs. The remedial inve sibility study leads to a decision that s method selected for remedial action to NPL site. Under the provisions of CERC facilities have the lead for CERCLA acti

Toxic Substances Control Act. *The stances Control Act* (TSCA) was enacte ensure that the manufacture, sale, s disposal of toxic chemical substances dc an unreasonable risk of injury to human environment. Its applicability to DOE principally with the management and polychlorinated biphenyls (PCBs), as dioxin. The problem created by radioa taminated PCBs, asbestos, and dio currently there is a limited capability tc materials. Radioactively contaminated PCB-contaminated materials generated b destroyed annually by the K-1435 TSCA at K-25 at Oak Ridge Reservation (ORR)

Clean Air Act. The original *Clean Air* was passed in 1955. It was wholly repla *Air Quality Act* of 1967, but the name *Cle* which was reauthorized in 1990, is still CAA establishes air quality requirer pollutant emission limits. The National Standards of Hazardous Air Pollutants (N a section of CAA that sets air quality stand emissions such as radionuclides, benzene, and asbestos. NESHAP regulations requ of EPA-approved monitoring instrum sampling methodology, calculations, and for each Federal facility.

Clean Water Act. The *Federal Water Control Act*, as amended by the *Clean* (CWA) of 1977, establishes a Federal/sta for controlling the introduction of pollutan Nation's water. The CWA created the Pollutant Discharge Elimination System program. This program regulates nonrac effluent discharges to ensure that surfa

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Waste Management PEIS and any respective site-specific NEPA documentation.

Treated waste is waste that, following generation, has been altered chemically or physically to reduce its toxicity or prepare it for storage or disposal. Waste treatment can include volume reduction activities, such as incineration or compaction, that may be performed on waste prior to either storage or disposal or both. Stored waste is waste that, following generation (and usually some treatment), is being temporarily retained in a retrievable manner and monitored pending disposal. Disposed waste is waste that has been put in final emplacement to ensure its isolation from the environment, with no intention of retrieval. Deliberate action is required to regain access to the waste. Disposed wastes include materials placed in geologic repositories or buried in landfills.

Waste that is staged for processing would be stored according to its characterization and form. The disposal of waste is managed by the DOE Office of the Assistant Secretary for Environmental Management (EM). A facility near Carlsbad, NM, for disposal of retrievable and newly generated transuranic (TRU) waste, is planned. All surface facilities at the Waste Isolation Pilot Plant (WIPP) have been completed. To date, only underground excavations for the test phase have been done, and the remaining excavation would be completed once the facility is operational. The original planned test phase has been abandoned, and in its place an experimental program at Idaho National Engineering Laboratory is being conducted to develop the technical data to support the permit application under 40 CFR 191 and 40 CFR 268. Once operational, WIPP would become a permanent disposal site. The total projected capacity of WIPP is 175,543 cubic meters (m^3) (229,602 cubic yards [yd^3]), of which 7,080 m^3 (9,260 yd^3) could be remote-handled.

A supplemental environmental impact statement (EIS) is being prepared for the proposed phased development of WIPP for disposal of TRU waste. This supplemental EIS will analyze the impacts of waste storage, characterization, certification, processing or treatment, and loading at the generator sites. It will also discuss the impacts of transportation of TRU waste between generator sites and WIPP. The impacts of waste disposal operations at WIPP will also be analyzed, including the impacts of waste receipt, waste package inspection, monitoring, emplacement, and subsequent activities associated with eventual closure, decommissioning, and institutional control of WIPP once disposal operations have been completed. Options for the interim storage of TRU waste are evaluated in the *Draft Waste Management Programmatic Environmental Impact Statement* (DOE/EIS-0200-D). Yucca Mountain, NV, is a site being studied to determine its suitability for the disposal of commercial spent nuclear fuel and Department of Defense high-level waste (HLW). To date, no decisions to utilize either the Yucca Mountain repository or WIPP have been made. The remainder of this section discusses some of the treatment, storage, and disposal options that may be utilized with the various waste streams from stockpile stewardship and management facilities.

Gaseous Waste. Gaseous wastes can be nonhazardous (e.g., inert gases and air), hazardous (e.g., chlorinated hydrocarbon vapor and polyaromatic hydrocarbon vapor), or radioactive (e.g., tritium and xenon). Most hazardous gaseous wastes that are combustible may be incinerated to destroy the hazardous constituents by converting the combustibles into carbon dioxide and water vapor, while capturing any particulates that may result. When a particulate (ash) is contaminated with heavy metals, the end product must be stabilized into an approved solid form suitable for disposal.

Gaseous radioactive wastes are held for interim storage in tanks; adsorbed on surfaces in filters, molecular sieves, or active beds; refrigerated and liquefied or solidified; or reacted to form an aqueous solution. Gaseous waste may be oxidized, mixed with other liquid wastes, or solidified in a stable form for long-term disposal. Reactive gases such as tritium are captured on reactive beds, in molecular sieves, or in cryogenic traps for recycling back to the process. Inert radioactive gases such as xenon and argon can be separated by cryogenic capture and held in storage tanks until they decay sufficiently to permit release. Gases that decay to metals can be captured on activated charcoal beds and held until they can be stabilized, packaged, and disposed of as solid waste. When sufficiently decayed, gases may be released to the atmosphere.

Liquid Waste. Liquid waste includes both wastewaters and nonwastewaters. Wastewaters are a mixture of water and organic, inorganic, or radioactive contaminants. Liquid radioactive wastes are processed

according to their chemical nature and radiological sources and activities. Liquid wastes that meet release criteria in applicable regulations can be released at permitted discharge points. Where conditions permit, liquids can be processed and recycled to replace virgin feedstocks. Waste processing removes the hazardous or radioactive contaminants from the releasable or recyclable liquids. The largest volume of liquid radioactive waste is low-level waste (LLW), typically in aqueous solution from process operations. Some of this waste is contaminated with hazardous compounds such as solvents or resins, and the result is a liquid mixed waste. Liquid HLW would not be generated in stockpile stewardship and management facilities, but is part of the reference conditions at candidate sites where spent fuel or target processing was conducted. The desired final waste form for liquid wastes is a stable solid that is resistant to stresses from heat generation and from internal and external physical loads. The form must remain stable while stored and the radioactive constituents must not be allowed to migrate to the surroundings.

Mixed waste often has combustible constituents. These are most readily decomposed in thermal treatment (incineration) or chemical reaction resulting in the creation of an ash. The resulting material would be granular and suitable for stabilization in a cemented form in which the hazardous constituents (radionuclides and heavy metals) are bound in compounds that have an affinity for heavy metals and radionuclides. These processes have been utilized in various forms, and their retention properties have been credibly demonstrated.

Liquid LLW is normally processed to reclaim or remove the excess water, leaving a saturated salt solution. This can be accomplished by clarification processes normal to water treatment or by evaporation. This usually results in the greatest volume reduction for liquid waste. The subsequent stabilization and solidification of the concentrated solution results in a waste form that does not leach its active constituents for a time sufficient to allow the radioactive constituents to decay.

Liquid radioactive and hazardous wastes are usually stored in tanks, where they are staged for further processing. Processes are employed to concentrate the hazardous constituents. These processes result in significant volume reductions, with the reclaimed water processed to a purity sufficient for permitted discharge or recycle.

Liquid hazardous waste concentrates may contain combustive hydrocarbons and heavy metal contaminants. These can be treated by incineration to produce a dry waste. If this waste is still hazardous after treatment, it can then be processed into a stabilized solid that would not leach its hazardous constituents while in storage or in a disposal facility. Liquid low-level and noncombustible hazardous waste can also be processed into a stabilized solid form for storage and disposal.

Solid Waste. Solid radioactive waste typically consists of contaminated materials (e.g., filters, clothing, storage vessels, cleaning materials, and tools) that have been used in, or contaminated by, nuclear materials processing. The term is also applied to those stabilized forms resulting from gaseous or liquid waste processing. In solid waste handling, forms and materials would be segregated, combustibles could be incinerated, and the resultant materials would be reduced in volume, stabilized if necessary, and packaged in specified containers for storage or disposal.

The only HLW stored at sites considered for the Stockpile Stewardship and Management Program is liquid HLW in tanks at Savannah River Site (SRS). It would be processed to a borosilicate glass, stored in an engineered facility onsite, and eventually shipped to a Federal repository.

Dry LLW that consists of protective clothing, containers, process materials, and equipment is stored in specified containers designed to retain the waste constituents for a time sufficient to permit decay of the radioactive constituents.

Solid hazardous waste may contain combustible hydrocarbon compounds or mixtures with heavy metal contamination. These wastes are usually shipped offsite to RCRA-permitted commercial facilities where they are treated, if required, and disposed of. Wastes that retain their hazardous constituents after processing must be packaged into forms that would retain the hazardous constituents safely within the waste form. For LLW or hazardous waste that results from liquid waste processing or incineration, the accepted form is solidification with a cement-like bonding agent.

Some mixed waste can be processed to remove its hazardous constituents and can be disposed of as LLW. Otherwise, it can be processed into stabilized forms and packaged for storage in an engineered facility until a licensed facility is available for permanent disposal. Solid nonhazardous wastes from process wastewater evaporation ponds or from sanitary waste treatment plants are usually deposited as sludge in a landfill.

Sites under consideration for stockpile stewardship and management facilities tha do not have or have planned an onsite LLW disposal facility would ship their LLW offsite to one of DOE's LLW disposal facilities. As shown in table H.1.4–1, data from the DOE Integrated Database were used to calculate LLW disposal land usage factors from 1990 to 1993 for Los Alamos National Laboratory (LANL), Nevada Test Site (NTS), and SRS. ORR (Oak Ridge National Laboratory [ORNL]) is not listed because it only accepts ORNL-generated LLW. To determine a usage factor for the waste management impact analysis, an average value was calculated and then rounded down to the nearest hundred cubic meters. For the proposed Class II LLW disposal facility at ORR, a 3,300-m^3/hectares (ha) (1,700-yd^3/acre) usage factor was assumed (OR DOE 1995e:1).

H.1.5 Transportation

DOE complies with applicable Department of Transportation (DOT) regulations (10 CFR 71 and 49 CFR) when shipping hazardous materials over public roads. Transportation, especially for radioactive material, is highly regulated by Federal, state, and local laws. The stringent packaging requirements, combined with strict regulations and procedures governing the shipment of hazardous and radioactive materials, ensure that transport is a safe activity. Federal DOT regulations require the use of appropriate warning placards on vehicles and labels on packages to alert workers, officials, and the public to the hazardous nature of the shipped material. The use of placards on vehicles and warning labels on packages is a joint responsibility of the carrier and the shipper. The labels and placards are familiar to emergency response personnel and are valuable in determining content and hazard information.

Shipments of hazardous materials, including radioactive materials, must be accompanied by properly completed shipping papers such as bills of cargo manifests that contain detailed infor the material being transported. These pape kept in the vehicle transporting the materia be available for inspection by responsible any time. The shipper must certify on the papers that the hazardous material of transport is properly classified, packaged labeled, and made ready for transport accor DOT regulations.

Radioactive material is shipped in secure Type A packages contain small amounts o tive material and are designed to withstar conditions of transport. Type A pack subjected to rigorous water spray, free-fall sion, and penetration tests carried out in se ensure that radioactive materials are contair B packaging is designed to contain more h and larger amounts of, radioactive waste withstand severe accident conditions anc radioactive materials under any credible stance.

If WIPP is determined to be a suitable facility for TRU and mixed TRU wastes pu the requirements of 40 CFR 191 and 40 C TRU wastes would be shipped in TRUPACT tact-handled) and RH-72B (remote-handl tainers. No remote-handled waste is expec generated in any of the stockpile steward management facilities. To determine the nu TRU waste shipments required, 8.7 m^3 (11. waste per truck shipment, 17.5 m^3 (23 yd^3) per regular train shipment, and 52.4 m^3 (69 waste per dedicated train shipment was a (DOE 1994v:B-4).

The additional shipments of LLW from st stewardship and management sites withou LLW disposal were estimated. All LLW w transported in a solid form. A typical sh would consist of 80 208-liter (L) (55-gallo drums loaded into an enclosed semi-trail truck. Each drum is assumed to be fully resulting in a total shipment volume of (21.7 yd^3). The truck is assumed to operat "exclusive-use" vehicle.

TABLE H.1.4–1.—*Low-Level Waste Disposal Land Usage Factors for Department of Energy Sites*

Site	Total Cumulative Volume (m^3)	Estimated Area Utilized (ha)	Land Usage Factor (m^3/ha)
1993			
LANL	220,700	17.4	12,684
NTS	458,435	174.2	2,632
SRS	665,239	67.9	9,797
1992			
LANL	218,000	17.2	12,674
NTS	439,700	55.0	7,995
SRS	649,700	78.2	8,308
1991			
LANL	215,700	17.2	12,541
NTS	419,600	55.0	7,629
SRS	636,700	78.2	8,142
1990			
LANL	209,900	17.0	12,347
NTS	408,400	No Data	No Data
SRS	612,800	72.1	8,499
Average			
LANL	NA	NA	12,562
NTS	NA	NA	6,085
SRS	NA	NA	8,687

Note: NA - not applicable.
Source: DOE 1991h; DOE 1992f; DOE 1994c; DOE 1994d.

H.1.6 Facility Transition Management

Any transition activities of facilities from a production mode to a cleanup mode that are part of the baseline for this PEIS are discussed as appropriate in the impacts sections of chapter 4 and in section H.2 of this appendix. Decontamination and decommissioning (D&D) considerations of stockpile stewardship and management facilities would be planned for in the design.

The DOE Office of the Assistant Secretary for Defense Programs (DP) is responsible for the safe operation, shutdown, and ultimate disposition of facilities used to support the nuclear weapons program. EM is responsible for final facility disposition, which may include D&D of inactive facilities or refurbishment of them for further economic development. Transition activities would require appropriate NEPA evaluation and would proceed consistent with programs within EM, DP, and Materials Disposition. Depending on the site, facility transition activities are in different stages of planning. The dominant time-intensive activities are building characterizations of the environmental hazards related to the building and the deactivation of the facility.

At the end of their useful lives, all potential facilities would require decommissioning. The transition process begins when DOE management decides to stop operating the production facility and ends when responsibility for the facility is formally turned over to EM. Transition plans would be required for all facility transfers to EM. These plans define the actions necessary to bring the identified facilities into a condition acceptable for transfer to EM. Some facility transition issues that would be considered in the facilities design process are:

- Land-use criteria defined for the period after cleanup
- Interim storage of mixed waste
- Disposal facilities for hazardous and LLW

The cleanup of proposed stockpile stewardship and management facilities would be significantly less difficult because consideration for waste minimization and ease of decontamination would be included in the facility design. The surfaces that come in contact with potential contaminants would be easier to decontaminate. In-process decontamination (to reduce operational exposures) would significantly reduce the cleanup required at the end of the facilities' life.

In spite of the best design and process practices, many of the proposed stockpile stewardship and management facilities would require decontamination efforts at the end of their life. Because of the necessity of working inside contaminated areas during the cleanup phase, the potential for exposure for cleanup workers is higher than during the operation phase. All D&D workers would wear protective clothing and would be supplied breathing air, as appropriate, to minimize their exposure.

Technologies for cleanup are established and are improving as experience in working with nuclear facilities increases. The use of robotics, improved task planning, and new materials to prevent the spread of contamination have already improved current cleanup activities. By the time the proposed stockpile stewardship and management facilities are decommissioned, DOE will have gained considerable cleanup experience; thus, further improvements should be expected.

H.2 Waste Management Activities

H.2.1 Oak Ridge Reservation

ORR consists of three operating industrial complexes in and around the city of Oak Ridge. The Energy Systems Waste Management Organization provides the waste management oversight for ORR. It also provides guidance to each of the operating facility waste management divisions that are responsible for operating and managing their respective waste management facilities and activities. Because there is no spent nuclear fuel, HLW, or TRU waste associated with the fabrication of secondaries and cases, there will be no further discussion of these wastes at ORR in this appendix.

Y-12 Plant. Laboratory, maintenance, construction, demolition, and cleanup activities; machining operations; and waste produced in the puri uranium for recycle are the primary waste activities at the Y-12 Plant (Y-12). In metal-plating operations generate plat solutions while various laboratory activiti reactive wastes and waste laboratory c Liquid process waste and the sludge resu the treatment of these process wastes are throughout the plant. Waste oils and so generated from machining and cleaning c Daily operations such as janitorial service sweepings generate both noncontaminate nium-contaminated industrial trash.

Pollution Prevention. The Y-12 Pollution F Awareness Program Plan describes th program in detail. The program is des maintain the flow of information pertaining minimization and pollution prevention and tate activities to implement real reductions generation. A summary description of the elements of the Waste Minimization and I Prevention Program includes a prom campaign, information exchange, a waste system, and waste assessment performance.

One goal of the program is to sustain an e pollution prevention effort by improv awareness of the employees of waste mini opportunities and activities. Improved awa accomplished in many ways including t posters, publications, seminars, promotion paigns, and recognition of individuals and te activities that reduce waste generation. Was mization activities at other ORR sites an weapons sites provide useful input to the p Using ideas developed by others is an im aspect that can save time and resources.

Tracking waste generation in a manner tha itself to waste minimization reporting is a pr site to documenting successes or failures in minimization efforts. Y-12 is improving its ab record and track waste shipments. Process assessments are being conducted as part ongoing program to identify, screen, and a options to reduce the generation of waste. This mines the amount of material in a workplace disposed of as waste during work operations assessment provides a summary of haza materials usage and waste production and ide those processes and operations that need

improved or replaced to promote waste minimization.

Low-Level Waste. Machining operations that use stock materials including steel, stainless steel, aluminum, depleted uranium, and other materials produce machine turnings and fines as waste products. Waste treatment provides controlled conversion of waste streams generated from operations to an environmentally acceptable, or to a more efficiently handled or stored, form. This activity includes continuing operation and maintenance of facilities that treat wastewaters and solid waste generated from production and production support activities. Waste minimization and planned treatment facilities are expected to reduce the magnitude of these wastes. In 1993, Y-12 treated approximately 1,030,000 L (272,000 gal) of liquid LLW and 4,730 m^3 (6,200 yd^3) of solid LLW (OR MMES 1995c:5-13). Table H.2.1–1 summarizes the LLW treatment facilities at Y-12 of which the major facilities are described below.

The Uranium Chip Oxidation Facility thermally oxidizes depleted and natural uranium (less than 1 percent enrichment) machine chips under controlled conditions to a stable uranium oxide. Upon arrival, chips are weighed, placed into an oxidation chamber, and ignited. The oxide is transferred into drums and transported to the uranium oxide storage vaults. The Uranium Chip Oxidation Facility is not designed to treat uranium sawfines. Hence, sawfines are currently blended with uranium oxide and placed in the oxide vaults as a short-term treatment method.

The Waste Feed Preparation Facility processes and prepares solid LLW for volume reduction by an outside contractor or storage at Y-12. The facility utilizes a 200-ton capacity baler to reduce the waste volume to one-eighth of its original size. Waste comes to the facility from areas known to generate contaminated material, or from dumpsters that were analyzed at the trash monitoring station and deemed to be above the radioactive acceptability limits for the sanitary landfill. The compacted bales are placed in DOT-approved metal boxes and staged in an adjacent warehouse prior to offsite shipment for incineration or storage at Y-12.

The Uranium Treatment Unit is located near Building 9206 and was used to treat uranium-contaminated nitrate waste solutions that a uranium recovery operation 9206. The RCRA closure issued in March 1995 and is the state.

The Waste Coolant Processi dation and storage facility may be LLW and utilizes tl for coolant treatment:

- Three storage tanks
- Feed tank
- Waste processing react
- Sludge holding tank
- Two sludge blenders/d
- Effluent holding tank
- Transfer pumps

Microorganisms biodeg 114,000 L (30,000 gal) of w into harmless products. Eac approximately 30 days to tre clarifier separates the was streams: floating oily solic settled biological solids. dewatered in the dryer/ribbo ferred to drums. Liquid efflu Pollution Control Facility (Facility/West Tank Farm for NPDES discharge. Biolog treated in the aeration tank a sent through the blender for cled solids are currently pu storage. This practice will treatment and disposal meth

Long-term storage options i houses, tanks, and vaults, as wastes in buildings at K-25. storage facilities, described b table H.2.1–2. As of June 7,930 m^3 (10,400 yd^3) o (6,210 yd^3) of uranium-cor were stored at Y-12 (OR MM

The Classified Waste Storage Facility (located in Building 9720-25) will provide for the permitted storage of solid LLW and mixed LLW, which is classified for national security purposes under provisions of the *Atomic Energy Act*. These wastes are currently being stored by the waste generators. The facility will meet plant security requirements for classified waste management and guidelines for the management of LLW and mixed LLW.

Containerized waste storage units in Buildings 9206 and 9212 provide for the storage of cans of ash resulting from the combustion of uranium-contaminated solid wastes. Combustible solid wastes contaminated with enriched uranium are turned into ash by oxidation during the uranium recovery process. The resulting cans of ash are stored in containerized storage units in Buildings 9206 and 9212 until uranium accountability results have been obtained and the material can be returned to the uranium recovery process for further processing to recover the enriched uranium.

The Depleted Uranium Oxide Storage Vaults I and II are located on Chestnut Ridge northeast of Building 9213. The vaults are constructed of reinforced concrete and provide a retrievable storage repository for uranium oxide, uranium metal, and a blended mixture of uranium sawfines and oxide. The vaults contain a negative pressure exhaust system that operates during material entry. The exhaust is filtered and monitored prior to its release to the atmosphere. The facility utilizes forklift trucks, electric hoists, and a motorized drum dumper during operation. Depleted uranium oxide and blended sawfines are delivered in sealed [illegible] 208-L (30- and 55-gal) drums. The containers have a weight limit of 386 kilograms (kg) (850 pounds [lb]).

The Old Salvage Yard contains both low-level uranium-contaminated and nonradioactive scrap metal. Most scrap currently sent to this facility is contaminated. The Contaminated Scrap Metal Storage is an area within the Old Salvage Yard that is used to store uranium-contaminated scrap metal. Contaminated scrap is being placed in approved containers and eventually will be transferred to the aboveground storage pads. Noncontaminated scrap is sold when offsite shipments are allowed. This facility is located at the west end of Y-12.

Y-12 has no current onsite LLW disposal
All disposal activities at the Bear Cr
Ground were terminated on June 30, 1
landfill was used to dispose of radiologica
inated solid waste. These wastes are cu
tainerized and stored at Y-12 in abovegro
pads or are shipped offsite for incineratio
approximately 187 m^3 (245 yd^3) of solid
LLW were sent offsite to be compacted or
with the ash returned to Y-12 fo
(OR MMES 1995c:5-15). Also, 745 m^3 (
contaminated scrap were sent to be smel
The proposed LLW disposal facilities pro
provide new disposal facilities at a new
location of ORR. The proposed LLW dis
ities would utilize state-of-the-art disposa
gies, including lined trenches with
collection treatment capabilities and tur
finement disposal units. The Class-II F
wastes contaminated with very low concer
short (less than 30 years) half-life radior
expected to be operational in 2002. DOE
nitely postponed construction of the Class
for wastes contaminated with very low
tions of predominantly long (greater than
half-life radionuclides.

Mixed Low-Level Waste. Mixed LLW is
from the development, metal preparatio
tion, and assembly/industrial engineering
at Y-12. Mixed LLW is hazardous was
solvents, degreasers, biodegradable coolan
and inorganic acids, biodenitrification sl
wastewater that is contaminated with enric
depleted uranium. There is no disposal
waste at Y-12; however, future plans includ
of mixed wastes at a permitted offsite cc
facility. Mixed wastes are put in storage
treatment or disposal, treated at Y-12,
another ORR facility for treatment and
Table H.2.1–3 presents the inventory of m
at Y-12 as of December 31, 1994, along wit
projection. In 1993, approximately 2,4
(636,000 gal) of liquid mixed LLW was
Y-12 (OR MMES 1995c:7-9). The Y-12 W
agement Division operates several mi
treatment facilities which are described b
summarized in table H.2.1–1.

The Groundwater Treatment Facility treats
ter from the Liquid Storage Facility at

seepwater collected at K-25 to remove volatile and nonvolatile organic compounds and iron. It is part of the Disposal Area Remedial Action program to collect and treat contaminated groundwater from the Bear Creek Burial Grounds. The Groundwater Treatment Facility is located at the far west end of Y-12, adjacent to the West End Treatment Facility. This facility utilizes an air stripping operation to remove volatile organics. In addition, carbon adsorption eliminates nonvolatile organics and PCBs. Iron removal equipment is also operational. After treatment, wastewater is sampled and recycled if additional processing is required. Wastewater that meets discharge specifications is pumped into East Fork Poplar Creek through an NPDES monitoring station. The Groundwater Treatment Facility treated and discharged approximately 2,780,000 L (735,000 gal) during 1992 (DOE 1994n).

The West End Treatment Facility/West Tank Farm treats the following nitrate-bearing wastes generated by Y-12 production operations: nitric acid wastes, nitrate-bearing rinsewaters, mixed acid wastes, waste coolants, mop water, caustic wastes, and biodenitrification sludges. Treatment operations consist of biological denitrification, biological oxidation, metals precipitation, coagulation, flocculation, clarification, filtration, hydrogen-ion concentration adjustment, degassification, and carbon adsorption. Wastes are received at the West End Treatment Facility/West Tank Farm in 18,900-L (5,000-gal) tankers, 2,270-L (600-gal) polytanks, and in smaller, approved waste transportation containers such as drums, bottles, and carboys. Detailed waste analysis documentation is used to determine the treatment scheme and temporary storage location of each shipment. The West End Treatment Facility effluent polishing system facilitates the removal of uranium, trace metals, and suspended solids. The treated wastewater is then discharged to East Fork Poplar Creek through an NPDES monitoring station. Sludges, spent carbon, and spent filter material generated during the treatment processes are currently stored in 1,890,000-L (500,000-gal) tanks. A major modification to the West End Treatment Facility/West Tank Farm is currently in the design phase. This modification will remove all heavy metals up front, thus separating the hazardous sludge from the nonhazardous sludge. Approximately two-thirds of the current sludge volume generated can then be disposed of as nonhazardous wastes.

The Y-12 Cyanide Treatment Unit p
and treatment of waste solutions con
cyanide compounds from spent pla
precious metal recovery operations
The cyanide reduction process perfo
unit is currently performed in 208-L (
ers. After waste is treated at the Cya
Unit, it is transferred to the West
Facility for further treatment then di
East Fork Poplar Creek.

As of June 1994, approximate
(21,700 yd^3) of mixed LLW were
(OR MMES 1995c:7-32). Table H
rizes the mixed LLW storage facilit
are described below.

The Containerized Waste Storage A
three concrete pads covering appro
square meters (m^2) (24,800 square fe
pads provide storage for LLW, RCRA
mixed LLW. An impermeable dike
pad to provide spill containment. Fi
this facility will be upgraded, conting

The Building 9811-1 RCRA Storage
and OD8) contains a diked storage
(OD7) and an enclosed storage area
(OD8) with a capacity of 1,000 dru
contains four 114,000-L (30,000-g
37,900-L (10,000-gal) tanks, and as
and pumps. RCRA waste oil/solvent
taining various concentrations of c
nonchlorinated hydrocarbon solvents
PCBs, and water for specific chemic
are stored at OD8 in 208-L (55-g
1,140-L (300-gal) Tuff-tanks to awai
analytical results. Wastes deemed c
OD7 materials are pumped into thos
compatible wastes are transported to
ties.

The Waste Oil/Solvent Storage Faci
permitted RCRA TSCA hazardous
facility. It consists of a diked area
151,000-L (40,000-gal) tanks, a t
station with five centrifugal transfe
drum storage area. Three tanks hou
contaminated with uranium, one tank
dioactive PCB wastes, and one tan
hazardous wastes. Likewise, a dike
pad furnishes space for 33 m^3 (43 yd

ized waste. Wastes assigned to this facility are first stored at OD8 (Building 9811-1 RCRA storage facility) to await laboratory results. The diked area contains additional space for a sixth 151,000-L (40,000-gal) tank. This facility is projected to be used until 2010, due to the anticipated lack of disposal outlets for uranium-contaminated organic liquids.

The Liquid Organic Waste Solvent Storage Facility (OD10) contains four 24,600-L (6,500-gal) and two 11,400-L (3,000-gal) stainless steel tanks for storage of ignitable nonreactive liquids, including those contaminated with PCBs and uranium. In addition, a diked and covered storage area provides space for 40,000-L (10,600 gal) of containerized waste. The facility is capable of segregating various spent solvents for collection and storage. Major solvent waste streams are transferred to tanks until final disposition.

Building 9720-9 storage area supplies a drum storage area for mixed and PCB wastes, including an area designed to contain flammable wastes. The western half, which contains space for approximately 1,500 drums, stores both PCB and RCRA hazardous waste. The facility's eastern half is not currently in use. Upgrades are underway to the ventilation, diking, and fire-suppression systems to comply with RCRA, TSCA, and DOE standards and to allow for mixed and PCB waste storage.

The RCRA Staging and Storage Facility (Building 9720-31) prepares solid, liquid, and sludge wastes for offsite shipment. The facility consists of seven storage rooms and seven staging rooms, each with a separate ventilation system. The staging rooms house small containers that are packed with compatible materials and shipped. The storage rooms hold larger containers, such as 208-L (55-gal) drums. Each room, which can hold up to 90 drums, accommodates a different class of hazardous waste.

The RCRA and PCB Container Storage Area (Building 9720-58) is a warehouse facility utilized for staging prior to treatment or disposal of PCB-contaminated equipment (transformers, capacitors, and electrical switchgear) and nonreactive, nonignitable RCRA waste contaminated with uranium. Waste containers received at Building 9720-58 include 114- and 208-L (30- and 55-gal) drums, 1,250- and 2,500-L (330- and 660-gal) portable ta boxes, and self-contained PCB equipmen

The Solid Storage Facility provides (17,500 ft^2) of storage space for PCB nium-contaminated soil. The facility also synthetic liner for leachate collection detection system. Collected leachate is tra the Liquid Storage Facility for pretreatr Solid Storage Facility is currently unde RCRA Part B permitting process. No wastes are being added to the facility.

Hazardous Waste. Plating rinsewaters, wa solvents from machining and cleaning o contaminated soil, soil solutions, and soil from RCRA closure activities; and waste nated with hazardous constituents from tion/demolition activities are the major s hazardous waste. In 1993, appro 8,840,000 L (2,340,000 gal) of hazardc were treated (OR MMES 1995c:6-6). The hazardous waste consists of 1,080 m^3 (1,4 solid waste which is stored at the RCRA St Staging Facility. In 1994, approximatel (250 yd^3) of PCB hazardous material wa offsite for treatment (DOE 1995h). The Y Management Division operates several h treatment facilities that are described belo summarized in table H.2.1–4.

The Plating Rinsewater Treatment Facil dilute plating rinsewaters contaminated with chromium, copper, nickel, and zinc. In the facility can treat cyanide-bearing wa remove chlorinated hydrocarbons. Th capacity for this facility is 30.3 million l/yr (million gal/yr [MGY]). Under normal co the Plating Rinsewater Treatment Facili 852,000 L (225,000 million gal) of plating ter per year (DOE 1995gg). The facility i across the street from the Building 9401-2 shop, which produces most of Y-12's rins The facility neutralization, equalization, and destruction equipment is located outdoors in basin. The remainder of the facility pr located in Building 9623. Rinsewaters are via a direct pipeline from the plating sl addition, rinsewaters may be received in polytanks, or in any acceptable waste shipp tainer. The Plating Rinsewater Treatment performs the following treatment operati

adjustment, flow equalization, heavy metal removal by electrochemical precipitation, flocculation, clarification, carbon adsorption, and filtration. After the clarification operation, the rinsewater is transferred to the Central Pollution Control Facility. The Central Pollution Control Facility provides the carbon adsorption operation, final filtration, and discharge to East Fork Poplar Creek through an NPDES monitoring station. Treated rinsewater is sometimes recycled for use as make-up water for Central Pollution Control Facility processes. Sludge from the clarification process is transferred to the Central Pollution Control Facility and then taken to the West Tank Farm for interim storage.

The Steam Plant Wastewater Treatment Facility treats approximately 144 MLY (38 MGY) of wastewater from steam plant operations, demineralizers, and coal pile runoff (OR MMES 1995c:8-7). Treatment processes include wastewater collection/sedimentation, neutralization, clarification, pH adjustment, and dewatering. The treatment facility utilizes automated processes for continuous operation. All solids generated during treatment are nonhazardous and are disposed of in the sanitary landfill. The treated effluent is monitored prior to NPDES discharge to the East Fork Poplar Creek. The Y-12 utilities department manages this facility.

Hazardous waste is being stored until the management and operations contractor and DOE approve shipment for offsite disposal under the DOE "No Rad Added" performance objective. As of June 1994, approximately 60 m^3 (79 yd^3) of hazardous waste and 20 m^3 (26 yd^3) of PCB wastes was in storage at Y-12 (OR MMES 1995c:6-11). Table H.2.1–5 summarizes the major existing Y-12 hazardous waste storage facilities described below.

The Oil Landfarm Soil Storage Facility contains approximately 420 m^3 (550 yd^3) of soil contaminated with PCBs and volatile organics (OR DOE 1993a:9-21). The soil was excavated from the Oil Landfarm and Tributary 7 in 1989. The soil is contained in a covered, double-lined concrete dike with a leak-detection system. The leak-detection system will soon be modified to enhance detection capabilities.

The Liquid Storage Facility of the Disposal Area Remedial Actions Liquid Storage Treatment Unit is a hazardous waste storage facility built during the Bear Creek Burial Ground closure activities. in Bear Creek Valley approximately 3.2 (km) (2 miles [mi]) west of Y-12. It c stores groundwater and other wastewate from the seep collection lift station, the S Facility, tankers, polytanks, and the rainfall accumulation. Feed streams may contaminated with PCBs, volatile and organic compounds, and heavy metals. and storage equipment include:

- Two 284,000-L (75,000-gal) bulk st tanks
- 22,700-L (6,000-gal) oil storage tan
- Gravity separator
- Filtering unit
- Composite sampling station
- Tanker transfer station

The wastewater travels through the gravit cartridge filters, and composite sampling s to storage in the bulk tanks. A reinforce dike surrounds all equipment to provide sp ment. After sufficient wastewater accumu bulk storage tanks, it is processed at the G Treatment Facility. A new leachate collect collects and pumps hazardous waste see the burial ground to the Liquid Storage Fa

The Y-12 Waste Management Divisio Industrial Landfill V, which provides for t of industrial and institutional solid waste wastes such as asbestos materials, emp cans, materials contaminated with beryll glass, fly ash, coal pile runoff sludge, empt containers, and Steam Plant Wastewater Facility sludge. The landfill area is l Chestnut Ridge near the eastern end of the serves Y-12, ORNL, K-25, and other D contractors at Oak Ridge. The landfi shallow land burial by the area fill meth permitted by the State of Tennessee. Re filed with the state to provide disposal for materials as needed.

The Chestnut Ridge Borrow Area Waste P trial Waste Landfill III) consists of mercur

inated soil removed from the Oak Ridge Civic Center area and deposited at Y-12 Chestnut Ridge. No further disposal at this site has been made.

Nonhazardous Waste. Major waste-generating activities include construction and demolition activities that produce large volumes of noncontaminated wastes, including lumber, concrete, metal objects, and soil and roofing materials. Industrial trash is generated by daily operations throughout the plant. These operations include janitorial services, floor sweepings in production areas, and production activities. In 1993, Y-12 generated 145 million L (38.3 million gal) of industrial and sanitary liquid waste (OR MMES 1995c:8-5) that included oils and solvents, operational wastewater, Central Pollution Control Facility/Plating Rinsewater Treatment Facility wastewater, steam plant wastewater, environmental restoration waste, and liquid waste received from ORNL and K-25. The Waste Storage Facility in Building 9720-25 has a solid waste baler with an 8:1 compaction ratio (DOE 1994n). Approximately 43,900 m^3 (57,600 yd^3) of solid nonhazardous waste were compacted and/or stored during 1993 (OR MMES 1995c:8-5).

The Sludge Handling Facility (T-118) was designed and constructed to provide water filtration and sludge dewatering in support of a storm sewer cleaning and relining project. Filtered water was reused by the sewer-cleaning contractor, and the dewatered sludge was stored in specially constructed containers for future disposal. The facility is currently being used to store containers of LLW.

The Steam Plant Ash Disposal Facility is used to collect, dewater, and dispose of sluiced bottom ash generated during operation of the coal-fired steam plant. An additional trench was constructed for the disposal of sanitary and industrial wastes generated by ORNL, K-25, and Y-12. In order to comply with environmental regulations for landfill operations, the Steam Plant Ash Disposal Facility includes a leachate collection system, a transfer system to discharge the collected leachate into the Oak Ridge public sewage system, groundwater monitoring wells, and a gas migration/ventilation system.

In 1992, approximately 677 m^3 (887 yd^3) of clean scrap metal was stored at Y-12 (OR DOE 1993b:9-6). The new salvage yard is used for the staging and public sale of nonradioactive, nonhazard metal. Sales have been suspended, howe procedures to meet the DOE "No Rad Adde mance objective have been approved. Salvage Yard provides accumulation an activities for nonradiologically contamin metal. Plans are in place to provide an a lead cell battery repository for used batte recycling options are initiated. This facility near the Bear Creek Burial Ground.

The new Industrial Landfill V and Con Demolition Landfill VI permits disposal of mately 93,500 m^3/yr (122,000 yd^3/yr) of and sanitary waste (OR MMES 1995c:8- facilities were designed and operated in ac with Tennessee solid waste disposal regul baler, located in Building 9720-25, is used paction of sanitary/industrial solid waste de the Industrial Landfill V.

Oak Ridge National Laboratory. Becau is a research facility, it has many diverse w erating activities, each of which may produ small quantity of waste. Isotope production and support functions such as photography tional sources of waste. The radioactiv produced by each activity at ORNL reflect t of its operation. A large number of radioiso handled, in isotope production and packa reactor and accelerator operations, in repr studies on nuclear fuel, and in investigation interactions of radioactivity with living syste radioactive wastes generated by these activ be classified as follows:

- Concentrates generated by the treatm of intermediate-level wastes, which disposed of by hydrofracture.
- LLW contaminated with beta/gam emitting radioactivity. These wast which have a low surface dose rate, compacted, if possible, and disposed of earthen trenches; those wastes th exhibit a high surface dose rate a disposed of in augered holes.
- Low-level alpha-emitting wastes, whi are evaluated for criticality hazar before disposal in augered holes.

Pollution Prevention. Waste segregation is used to minimize the generation of solid LLW. By providing collection barrels for both radioactive and nonradioactive wastes, the volume of wastes that requires handling as radioactive waste has been reduced. Before these procedures were implemented, radioactive and nonradioactive wastes were discarded in the same barrel. This contaminated the nonradioactive portion and required special disposal of an inflated amount of waste.

Low-Level Waste. Isotope production and research activities generate a variety of low-level radioactive wastes to include low-level wastewater. Sources of solid LLW include contaminated equipment, filters, paper, rags, plastic, and glass and sludge from the Process Waste Treatment Plant. Table H.2.1–6 shows the LLW treatment facilities that are operating at ORNL. In 1993, 434 m^3 (569 yd^3) of solid LLW were compacted and 180,000 L (47,700 gal) of liquid LLW were solidified at ORNL. Approximately 25 m^3 (33 yd^3) were sent offsite to be compacted and/or incinerated (OR MMES 1995c:5-14, 5-15).

Solid LLW to include radioactive scrap metal is placed in storage prior to disposal. Table H.2.1–7 lists the LLW and mixed LLW storage facilities currently operating at ORNL. As of June 1994, approximately 1,050 m^3 (1,370 yd^3) of solid LLW and 2,960 m^3 (3,870 yd^3) of radioactive scrap metal were in storage awaiting disposal at ORNL (OR MMES 1995c:5-27).

The area designated as SWSA-6 at ORNL is the only active onsite disposal unit on ORR. It receives solid LLW, including radioactively contaminated asbestos. Table H.2.1–8 lists the LLW disposal units at SWSA-6. As of the end of 1993, approximately 606 m^3 (794 yd^3) of solid LLW were buried at SWSA-6 (OR MMES 1995c:5-29).

Mixed Low-Level Waste. Mixed wastes are generated by research projects and some facility operations. Isotope production and research activities generate a variety of mixed low-level and mixed TRU wastes. Table H.2.1–9 presents the inventory of mixed LLW at ORNL as of December 31, 1994, along with a 5-year projection.

As shown in table H.2.1–6, three facilities are currently treating or are capable of treating mixed waste at ORNL: the Process Waste Treatment Plant, the Liquid Low-Level Waste Evaporation Facility, and the Melton Valley Low-Level Waste Immobilization Facility (DOE 1995gg). One other treatment facility at ORNL, the Nonradiological Wastewater Treatment Plant, is operating and could be used to treat mixed waste.

The Process Waste Treatment Plant is designed to treat process wastewaters, groundwater, and evaporator condensate wastewaters that contain low levels of radioactivity. Small concentrations of radioactive materials have occasionally been processed. Process wastewaters may contain small quantities of radionuclides, metals, anions, and organic chemicals. Under normal operating conditions, the Process Waste Treatment Plant can process wastewater at a rate of 492 L/minute (min) (130 gal/min). The design capacity is 757 L/min (200 gal/min) (DOE 1994n). Wastewaters can contain organic materials and low levels of radioactivity. The facility can treat waste streams with some heavy metals but not streams containing PCBs.

The Liquid Low-Level Waste Evaporation Facility treats liquid LLW using evaporation. It operates in a semicontinuous mode; waste is accumulated in collection tanks and transferred through underground piping to an evaporator system. The design capacity is 106,000 L/day (28,000 gal/day). The facility processes an average of 1,140 L (300 gal) of liquid wastes per day under normal operating conditions (OR DOE 1993a:9-22). The facility can treat waste streams containing organic contaminants.

A summary of the mixed LLW storage facilities at ORNL is shown in table H.2.1–7. An estimate of the capacity of these facilities is also given. As of June 30, 1994, approximately 3,190 m^3 (4,180 yd^3) of mixed waste were in storage at ORNL (OR MMES 1995c:7-32).

The only disposal of mixed waste done at ORNL is the burial of radioactive asbestos at SWSA-6. Asbestos contaminated with low levels of radioactivity is placed in silos. In 1992, approximately 23 m^3 (30 yd^3) of contaminated asbestos was buried (OR DOE 1993b:9-4). Low-level contaminated biological waste has also been buried at SWSA-6.

Hazardous Waste. Hazardous wastes are generated in laboratory research, electroplating operations, painting and maintenance operations, descaling,

demineralizer regeneration, and photographic processes. Few hazardous wastes are treated in onsite facilities. Onsite treatment at ORNL includes elementary neutralization and detonation facilities. A summary of the hazardous waste treatment facilities at ORNL is shown in table H.2.1–10.

The Chemical Detonation Facility treats small amounts of wastes that would be dangerous to transport offsite. Explosives such as aged picric acid are detonated in the detonation facility. Certain other wastes (e.g., spent photographic processing solutions) are processed onsite into a nonhazardous state. Those wastes that are safe to transport are shipped to offsite RCRA-permitted commercial treatment/disposal facilities.

The Nonradiological Wastewater Treatment Plant is designed to reduce pollutant concentrations in nonradiological wastewaters including hazardous wastes to levels acceptable for effluent discharge. The plant operates in a continuous mode and involves physical and chemical processing steps. The facility contains a heavy-metal removal system, where the pH of the wastewater is raised to 10.5 in a clarifier. Polymers are added to induce flocculation and settling of the metal precipitates. The wastewater is passed through a filtration system to remove particulates. An air stripper then removes volatile organics and activated carbon columns remove mercury. In 1993, approximately 23,800,000 L (6,300,000 gal) of liquid hazardous wastes were treated at the Nonradiological Wastewater Treatment Plant (OR MMES 1995c:6-6).

As of June 1994, approximately 60 m^3 (79 yd^3) of hazardous waste and 20 m^3 (26 yd^3) of PCB waste were stored at ORNL (OR MMES 1995c:6-11). PCB wastes are managed in storage facilities until they can be shipped offsite for treatment and/or disposal. PCB-contaminated and hazardous wastes are temporarily stored at Building 7507, and PCB-contaminated wastes are stored on the 7507W storage pad. Due to the "No Rad Added" policy, hazardous wastes are being stored as mixed waste. A listing of the hazardous waste storage facilities at ORNL is shown in table H.2.1–11. Approximately 10 m^3 (13 yd^3) of asbestos wastes were sent offsite in 1992 to Y-12 Sanitary and Industrial Landfill II. About 12 m^3 (16 yd^3) of hazardous and PCB wastes were sent to K-25 for storage and incineration in the TSCA incinerator (OR DOE 1993b:9-5).

Nonhazardous Waste. Nonhazardous w
from ORNL maintenance and utilities.
plant and the sanitary waste treatment pl
a sludge which is sampled to demonstra
nonhazardous and meets the Y-12 Ind
Sanitary Landfill II waste acceptance cr
sewage treatment facility treats sanitary a
wastewater. It is an extended aeratior
sludge unit followed by mixed media ter
tion of secondary effluent dewatering. Th
dried onsite in open-air drying beds.
approximately 331 million L (88 milli
industrial and sanitary liquid waste were
the sewage treatment plant (OR MMES 1

The Melton Valley Low-Level Waste Imm
Facility is currently treating nonhazard
waste (OR DOE 1994a:A-20). The facil
used to solidify liquid mixed LLW that
greater than 12.5 and that contains so
metals. This liquid mixed LLW is transf
tanks by interconnecting pipelines. Batche
are pumped from a liquid decantation sy
solidification system as required to provid
storage-tank capacity. The facility operate
campaign basis to provide adequate storag
Solidification is currently performed using
tion. Design capacity is 62,500 L (16,5
liquid waste per month. Under normal
conditions, the facility can process 7,57(
(mo) (2,000 gal/mo) as required to provide
storage-tank capacity. The facility cannot t
alpha-contaminated waste with TRU activ
greater than 100 nanocuries per gram
organic wastes, or PCBs.

Scrap metals are discarded from mainten
renovation activities and are recycled when
ate. Construction and demolition proj
produce nonhazardous industrial wastes.
nonhazardous and medical wastes (after
autoclaved to render them noninfectious
scrap metal are sent to the Y-12 Indus
Sanitary Landfill II. Approximately 16 m^3
of scrap metal were placed in storage at (
1992. This waste will remain at ORNL u
characterized as nonradioactive per the '
Added" policy (OR DOE 1993b:9-7).

Rainfall runoff from the ORNL steam plant
storage area plus additional wastewater
sulfuric acid tank diked area runoff, stea

boiler blowdown, and water softener regenerate are collected in a basin. This waste is treated at the Coal Yard Runoff Treatment Facility.

K-25 Site. Enrichment, maintenance, decontamination, and R&D activities have generated a wide variety of waste at K-25. Because of its past uranium enrichment mission, uranium is the predominant radionuclide found in K-25 waste streams. Waste management activities are increasing. Low-level radioactive wastes from other DOE sites are placed in building vaults until a final disposition strategy is identified. Also, PCB wastes and RCRA wastes contaminated with uranium began arriving from other DOE sites in 1987 for incineration in the K-1435 TSCA incinerator. Tables H.2.1–12 and H.2.1–13 summarize the treatment and storage facilities, respectively, at K-25 that are capable of treating and storing multiple categories of waste.

Pollution Prevention. K-25 policy mandates minimization of waste generated while achieving compliance with applicable environmental regulations. Five waste reduction options are used at K-25: segregation, material substitution, process innovation, mechanical volume reduction, and recycling/reuse. In recent years, some aluminum cans, worker clothing, and office furniture have been recycled for use at K-25. Such recycling has saved approximately 1,150,000 kg (2,520,00 lb) of materials as of 1991. K-25 management supports the waste reduction program. An example of this program is the conversion to gas-fired boilers to reduce capacity excursions and, in effect, reduce or eliminate fly ash production.

Low-Level Waste. Solid LLW is generated by discarding radioactively contaminated construction debris, wood, paper, asbestos and trapping media. Solid LLW is also generated by process equipment and by removing radionuclides from liquid and airborne discharges. Currently, solid LLW is being stored for future disposal. Table H.2.1–14 shows the storage facilities that deal only with LLW. Specifics on some of the storage facilities are described below. Treatment of the current inventory of contaminated scrap metal at K-25 (as well as at Portsmouth, Paducah, and Fernald facilities) is expected to occur over the next 3 to 5 years as part of a comprehensive DOE Scrap Metal Program to be managed through K-25. All contaminated scrap metal is stored aboveground at the K-770 scrap metal facility until further disposal methods are evaluated.

The Uranium Hexafluoride Cylinder
directed toward improving the safety an
of long-term storage for 7,000 cylinders
K-25. These cylinders remain from the
nated gaseous diffusion mission. In stora
are approximately 5,000 9-metric tons (
and 13-t (14 tons) cylinders of deplet
hexafluoride; 1,000 cylinders of normal
uranium hexafluoride; 400 cylinders cont
than 23 kg (50 lbs) of "enriched" materi
miscellaneous empty cylinders. The
Hexafluoride Cylinder Program is being
develop a clear understanding of the cu
tions of the cylinders and define any ne
long-term actions for safe storage of the
pending decisions on ultimate disposi
uranium hexafluoride material. Some o
actions in the program are a baseline in
corrosion coupon program, and an
thickness measurement program. Th
inspection identified a variety of cylinder
will require special attention and also ide
breached cylinders. Immediate correcti
have been taken to handle the breached cy
a schedule of activities has been deve
moving and repairing the cylinders.

The cylinders containing normal-assay fe
hexafluoride are currently being shipp
Paducah Gaseous Diffusion Plant. The cu
direction for the 5,000 cylinders with
uranium hexafluoride is to store them un
2020, at which time conversion to oxi
performed if no other uses have been dete
plan for cleaning the cylinders containing
110 kg (50 lb) of enriched material and e
not yet been approved (this may be per
K-25 or at one of the operating gaseous
plants).

Currently, there are no onsite disposal facil
operated at K-25. An ORR Centralized W
agement Organization has been establi
assigned the responsibility to design, cons
operate all new LLW disposal facilities
This organization is physically located at K

Mixed Low-Level Waste. Mixed LLW
consists of contaminated waste oils,
sludges, soils, and acid wastes. Table
presents the inventory of mixed LLW as of
31, 1992, along with a 5-year projection.

contaminated with low-level radioactivity were generated by settling and scrubbing operations and were stored in K-1407B and K-1407C ponds. Sludges have been removed from these ponds, and a portion have been fixed in concrete at the K-1419 Sludge Treatment Facility and stored at Building K-33. These materials are considered mixed LLW and will be shipped offsite for disposal at a permitted commercial facility.

Most of the treatment of mixed waste is at the TSCA Incinerator and the Central Neutralization Facility. The majority of waste treated at the TSCA Incinerator cannot be treated by commercial incinerators because of radioactive contamination. All waste sent to this facility must be fully characterized and identified. DOE has an approved chain-of-custody system for all waste received from offsite. The K-1435 TSCA Incinerator is capable of incinerating waste that is mixed or contains PCBs. In 1990, a limited amount of waste was incinerated as a part of the startup testing. The incinerator began full operations in early 1991 and met all regulatory requirements in processing 1,000 m^3 (1,310 yd^3) of mixed waste. Mixed TSCA waste is being generated in the ash residue at the TSCA Incinerator. Compliance issues regarding the management of the mixed PCB and radioactive waste generated in the ash are being pursued with EPA by DOE.

Most of the radioactively contaminated wastewater treated at the Central Neutralization Facility is generated at the TSCA Incinerator from the wet scrubber blowdown. Treated effluents are discharged through a designated release point. The contaminated sludges that precipitate in the sludge-thickener tank are stored in an approved aboveground storage area at K-25.

RCRA-mixed, radioactive land-disposal-restricted waste (including some nonradiological classified land-disposal-restricted waste) has been stored in some areas for longer than 1 year. These wastes are currently subject to the land disposal restriction that permits storage only for accumulation of sufficient quantities to facilitate proper treatment, recycling, or disposal. This waste is being stored because of the nationwide shortage of treatment and disposal facilities for this type of waste. Private-sector technology demonstrations are being conducted that involve uranium extractions from sludge.

Uranium-contaminated PCB wastes (wastes) are being stored in excess of the imposed by TSCA because of the lack c and disposal capacities. DOE and EPA ha Federal Facility Compliance Agreemen February 20, 1992, to bring the facility i ance with TSCA regulations for use, s disposal of PCBs. It also addresses th mately 10,000 pieces of nonradioactive taining dielectric equipment associate shutdown of diffusion plant operations.

In 1989, during routine inspections of th stabilized K-1407 pond sludge at the K-1 facility, it was discovered that many of the begun to corrode. Free liquid (waste with on top of the concrete in the drums was f causing the corrosion (OR DOE 1993a action plan has been implemented to dec dewater the mixed waste contained in the total of 45,000 drums of stabilized ma 32,000 drums of raw sludge must be pro moved to storage facilities that meet r governing mixed wastes. All containers wi ferred to and stored in new and existing f the K-1065 site, and the K-31 and K-33 bu

Hazardous Waste. Hazardous wastes ge K-25 include PCB articles and items, was items, and uncontaminated asbestos w hazardous wastes are managed according t ble state and Federal regulations and DC Several waste management facilities are place. Changing laws and regulations ha necessary to upgrade several facilities and and construct new facilities that reflect recent environmental technology. The Ce tralization Facility and the TSCA Incinerat two major facilities that treat hazardous wa

The Central Neutralization Facility pro adjustment and chemical precipitation fc aqueous streams throughout K-25. The mai of the Central Neutralization Facility i wastewater to ensure compliance with th ments of NPDES discharge limits on pH, he concentrations, and suspended solids. The system consists of two 94,600-L (25,(reaction tanks and a 227,000-L (60,(sludge-thickener tank. Acidic wastes are n with a hydrated-lime slurry, and basic waste

tralized with sulfuric or hydrochloric acid. The hydrated lime bin and acid tanks are located at the facility. The treatment facility is physically divided into two distinct sections for treating both hazardous and nonhazardous waste streams.

The TSCA Incinerator consists of storage tanks, dikes, and the incinerator. The incinerator system consists of a liquid, solid, and sludge feed system; a rotary kiln incinerator; and a secondary combustion chamber. The wastes treated at this facility include oils, solvents, chemicals, sludges, and aqueous waste.

In general, most of the waste stored at K-25 is designated as hazardous waste that has been contaminated with PCBs. Recyclable materials such as mercury and silver-bearing photographic wastes are stored before recycling, while other hazardous wastes are stored until sufficient quantity is accumulated for an offsite shipment. All offsite disposals of hazardous wastes were halted in 1991 until procedures addressing a DOE performance objective of "No Rad Added" were developed by the sites and approved by DOE Headquarters. Incineration is the preferred method for offsite treatment or disposal of wastes, particularly PCB wastes; however, landfills and other types of disposal are used as needed. On the K-25 Site all hazardous waste is treated as mixed LLW.

Nonhazardous Waste. Computer pap recycled from the K-25 Computer T Center. The program for recycling pap reviewed for expansion into nonradiolo Product substitutions at the paint shop an phy lab have resulted in a decrease of wa tion. No percentage of reduction has beer due to the lack of baseline data.

Waste assay monitors have been purcha being used to screen solid, potentially waste to determine the potential to man nonhazardous waste. The K-770 clean provides storage for nonradioactive scrap scrap metal is stockpiled before being public. The solid nonhazardous waste fr sent to Y-12 Industrial Landfill V. Som such as furniture, file cabinets, and pap through property sales. The only non treatment facility at K-25 is the Sanit Treatment Plant (Building K-1203). T consists of an extended aeration treatment a rate capacity of approximately 2,270, (600,000 gal/day). The current deman 1,140,000 L/day (301,000 gal/day) (O 1995c:8-9). The sanitary sludge is dispose Y-12 landfill. The Central Neutralizatio does treat some nonhazardous liquid was along with hazardous and/or mixed waste

TABLE H.2.1–1.—*Low-Level and Mixed Low-Level Waste Treatment Capability at Y-12 Plant* [Page 1 of 2]

Treatment Unit	Treatment Method(s)	Input Capability	Output Capability	Total Capacity[a] (m^3/yr)	Comment
Biodenitrification Unit (Bldg. 9818)	Neutralization, pH adjustment, nitrate removal	Liquid mixed LLW (nitrate solutions from enriched uranium recovery-Buildings 9212 and 9206)	Biosludge to West End Treatment Facility	2,100	RCRA permit-by-rule. Design capacity.
Central Pollution Control Facility	Filtration, carbon adsorption, oil/water separation, and sludge dewatering	Liquid LLW, mixed LLW, and hazardous waste (nonnitrate liquid wastes)	Treated wastewater discharged through NPDES outfall and solids to west tank farm	10,300	NPDES permit April 28, 1995. RCRA permit-by-rule. Design capacity.
Cyanide Treatment Facility (Bldg. 9201-5N)	Chemical oxidation, pH adjustment	Liquid mixed LLW and hazardous waste (cyanide spent plating batches)	Wastewater to West End Treatment Facility	15	RCRA permit issued September 25, 1995. Also has 8 m^3 of mixed waste storage. Assumed operation is 250 days/yr, 8 hr/day.
Groundwater Treatment Facility (Bldg. 9616-7)	Carbon adsorption and air stripping	Liquid LLW and mixed LLW (liquid storage facility groundwater)	Groundwater air stripper effluent, spent carbon, and sludge to depleted uranium oxide storage vaults and liquid effluent through NPDES outfall	9,450	NPDES permit April 28, 1995. Facility may be treating mixed waste, but is intended for hazardous waste only. Maximum capacity is 17,700 m^3/yr.
Interim Reactive Waste Treatment Area	Open burning	Solid LLW (sodium-potassium waste)	Treated residue waste to depleted uranium oxide storage vaults and treated waste to K-25	Campaign 2 times per year, 8 hours per campaign, 57 L/day	RCRA permit application submitted August 1992. Design feedrate is 0.7 m^3/yr.
Liquid Storage Facility (Bldg. 9416-35)	Oil/water separation by filter cartridges	Liquid mixed LLW (leachate from certain capped burial grounds in Bear Creek Valley)	Stored liquids to groundwater treatment facility and PCB-laden oil to TSCA incinerator	9,450	Also a storage unit. Facility may be treating mixed waste, but is intended for hazardous waste only. RCRA permit-by-rule.
Uranium Chip Oxidation Facility	Thermal oxidation	Solid LLW (depleted and normal uranium chips)	Uranium oxide to Depleted Uranium Oxide Storage Vaults	Classified yearly treatment	Exempted from state air permitting requirements.
Uranium Recovery Operations (Bldg. 9206,	Leaching, filtration, dissolution, oxidation, evaporation, extraction	Metal and organic removal from aqueous stream, aqueous neutralization	All waste diverted to Bioidentification Unit	2,100	System is exempt from permitting requirements under agreement with the State. Same capacity as Acid

consideration for treatment.

TABLE H.2.1–1.—*Low-Level and Mixed Low-Level Waste Treatment Capability at Y-12 Plant* [Page 2 of 2]

Treatment Unit	Treatment Method(s)	Input Capability	Output Capability	Total Capacity[a] (m^3/yr)	Comment
Uranium Treatment Unit (Bldg 9206)	Filtration and precipitation	Liquid mixed LLW (uranium-contaminated organic solvents)	Organic waste to TSCA Incinerator at K-25	2 m^3/day	Closure plan submitted March 1995.
Waste Coolant Processing Facility (Bldg. 9983-78)	Extended activated sludge treatment, sludge drying	Liquid LLW and mixed LLW (contaminated waste coolants)	Oily solids to dewatering and drums, biological solids to dewatering, and liquid to Central Pollution Control Facility or West End Treatment Facility/West Tank Farm	756	Also a storage unit. Maximum capacity is 1,320 m^3/yr. RCRA permit-by-rule. Planned facility not currently funded.
Waste Feed Preparation Facility (Bldg. 9401-4)	Compaction	Compactible solid LLW	Compacted solid LLW to Y-12 Sludge Handling Pad	19,000	An exemption for the state air permit has been granted. Design feedrate is 23 m^3/hr. Intermittent operation at 8 hours/day and 2 days/week.
West End Treatment Facility (Bldg. 9616-7)	Absorption, anaerobic digestion, clarification, coagulation, filtration, flocculation, and precipitation	Liquid mixed LLW and hazardous waste (radioactive-contaminated and nonradioactive nitrate waste)	Liquid effluent through NPDES outfall	2,600	Permitted capacity NPDES permit issued April 28, 1995. RCRA permit-by-rule. Design capacity is 7,600 m^3/yr.

[a] For those facilities already in use, this is a normal operating capacity; whereas, for facilities under design or construction, this is a design capacity. Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds, results of treatability studies, and permit issuance.

Source: DOE 1993h; DOE 1994k; DOE 1994n; DOE 1995gg; OR DOE 1995g; OR MMES 1993f; OR MMES 1995c.

TABLE H.2.1–2.—*Low-Level and Mixed Low-Level Waste Storage Capability at Y-12 Plant* [Page 1 of 2]

Waste Oil/Solvent Bulk Storage Grade Facility	Input Capability	Total Capacity[a] (m^3)	Comment
Above Grade Storage Pads	Solid LLW	7,130	Aboveground storage of LLW until completion of Low-Level Waste Disposal Facility.
Southeast Switchgear Room Bldg. 9201-4 (Alpha-4)	Solid mixed LLW (Old shutdown process waste) and LLW	65	RCRA Part B storage permit issued on September 28, 1995. Permitted storage capacity.
Bldg. 9404-7 (PCB Drum Storage Facility)	Solid PCB and uranium contaminated waste	40	Storage of liquid and/or hazardous waste not permitted except for PCB waste. Capacity for 496 drums.
Building 9206, Container Storage Area	Liquid/solid LLW and mixed LLW	15	RCRA Part B permit issued September 28, 1995.
Building 9212, Container Storage Area	Liquid/solid LLW and mixed LLW	15	RCRA Part B permit issued September 28, 1995.
Building 9720-25S	Liquid/solid LLW and mixed LLW	334	This is a new facility that previously stored classified waste only. RCRA Part B permit issued September 28, 1995.
Classified Waste Storage Area (CWSA), Bldg. 9720-25	Solid LLW and mixed LLW	495	RCRA Part B permit issued September 28, 1995.
Container Storage Facility (Bldg. 9720-12)	Solid mixed LLW	105	RCRA permit issued September 28, 1995. Design capacity is 123 m^3. Also contains hazardous and nonhazardous classified waste.
Containerized Waste Storage Area	Liquid/solid LLW and mixed LLW	632	Three concrete pads. RCRA permit issued September 28, 1995.
Contaminated Scrap Metal Storage Yard	Solid LLW (uranium-contaminated scrap)	4,740	No permit necessary.
Cyanide Treatment Facility	Cyanide spent plating batches, mixed LLW	8	RCRA permit issued September 28, 1995. Also treatment facility for hazardous and mixed wastes.
DARA Solid Storage Facility	Solid mixed LLW	5,060	RCRA interim status. Facility full as of August, 1994. Currently within the Environmental Restoration Program.
Depleted Uranium Storage Vaults I and II (9825-A and B oxide vault)	Solid LLW (depleted uranium oxide and metal)	1,020	Two vaults of reinforced concrete.
East Chestnut Ridge Waste Pile	Solid mixed LLW (contaminated soil and spoil from closure of RCRA units)	901	RCRA permit application submitted June 1993.
Liquid Organic Waste Storage Facility (Bldg. 9720-45, OD-10)	Liquid and solid mixed LLW. Ignitable nonreactive and radioactive waste. Can also include hazardous waste.	147	RCRA permit submitted September 1994. Consists of six storage tanks and a diked and covered storage area of approximately 186 m^3. Additional 40 m^3 of drum storage.

Oil Land Soils Containment Pad	Soil contaminated with PCBs and volatile organics	612	temporary storage before treatment. RCRA permit issued June 30, 1989

TABLE H.2.1–2.—*Low-Level and Mixed Low-Level Waste Storage Capability at Y-12 Plant* [Page 2 of 2]

Waste Oil/Solvent Bulk Storage Grade Facility	Input Capability	Total Capacity[a] (m^3)	Comment
PCB and RCRA Hazardous Drum Storage Facility, Bldg. 9720-9 (western half)	PCB and RCRA hazardous waste	738	RCRA permit issued September 28, 1995. The practical capacity has decreased to 20 m^3 due to renovation. Much of inventory was moved to 9720–25s.
RCRA and PCB Container Storage Area (Bldg. 9720-58)	Solid mixed LLW	580	RCRA permit issued September 28, 1995. Permitted RCRA waste materials. Hazardous waste section included in hazardous waste storage table.
RCRA Staging Area (Bldg. 9720-31)	Liquid and solid mixed LLW and hazardous waste	170	RCRA permit issued September 28, 1995.
Sludge Basin	Solid LLW	2,720	NA
Solid Storage Facility	Solid mixed LLW and hazardous waste to include PCB-contaminated waste	3,100	RCRA permit application submitted June 1993. Contains waste pile contaminated with radioactivity. Facility is currently within the Environmental Restoration Program.
Waste Oil/Solvent Bulk & Storage Facility (Bldg. 9811-1, OD-7)	Liquid hazardous waste and mixed LLW (oils and solvents contaminated with uranium and PCBs)	568	RCRA permit issued September 28, 1995. Four 30,000-gal and three 10,000-gal tanks.
Waste Oil/Solvent Drum Storage Facility (Bldg. 9811-1, OD-8)	Liquid and solid hazardous waste, LLW and mixed LLW	402	RCRA permit issued September 28, 1995. Waste is eventually taken to OD-9 or OD-10.
Waste Oil/Solvent Storage Facility (Bldg. 9811-8, OD-9)	Liquid mixed LLW (including PCBs) and hazardous waste	757	RCRA permit issued September 28, 1995. Site includes five storage tanks. Also includes 33 m^3 of storage for drums.
West End Tank Farm	Mixed LLW (sludge)	9480	Permit by rule.

[a] Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds and permit issuance.

Note: NA - not applicable.

Source: DOE 1994n; OR DOE 1993a; OR DOE 1995g; OR MMES 1993f; OR MMES 1995c.

TABLE H.2.1–3.—*Mixed Low-Level Waste at Y-12 Plant*

Waste Matrix	Number of Waste Streams	Inventory as of December 31, 1992 (m^3)	Number of Waste Streams Five-Year Projection	Total Generation Five-Year Projection (m^3)
Contact-Handled				
Aqueous liquids/slurries	3	40	3	123
Organic liquids	4	314	4	383
Homogeneous solids	7	6,520	6	1,300
Soils/gravel	6	6,420	3	7
Debris waste	11	147	11	120
Labpacks	2	<1	None	None
Special waste	7	11	4	5
Other	3	9	1	<1
Total	43	13,461	32	1,938

Source: DOE 1995gg.

TABLE H.2.1–4.—*Hazardous Waste Treatment Capability at Y-12 Plant*

Treatment Unit	Treatment Method(s)	Input Capability	Output Capability	Total Capacity (m^3/yr)	Comment
Plating Rinsewater Treatment Facility (Bldg. 9623)	Chemical treatment followed by filtration.	Liquid industrial and hazardous wastes	Treated wastewater discharged through NPDES outfall	144,000	RCRA permit-to-rule. NPDES permit. Capacity based on maximum treatment in 1993.
Steam Plant Wastewater Facility	Cyanide destruction, pH adjustment, electrochemical chrome reduction, carbon adsorption and filtration.	Liquid hazardous (plating rinsewater) and mixed LLW	Treated wastewater discharged through Central Pollution Control Facility NPDES outfall and solids to West Tank Farm	144,000	RCRA permit-by-rule. NPDES permit. Capacity based on maximum treatment in 1993.

Source: DOE 1994n; DOE 1995gg; OR MMES 1995c.

TABLE H.2.1–5.—*Hazardous Waste Storage Capability at Y-12 Plant*

Storage Unit	Input Capability	Total Capacity (m^3)	Comment
Building 9418-9	PCB-contaminated mineral oil	53	Below-grade, diked tank.
Oil Drum Storage Area (OD3)	PCB-contaminated oils	45	Site is closed except for tanker.
Oil Landfarm Soils Storage Facility	Solid hazardous waste contaminated with PCBs and volatile organics (excavated soil from the closure of the Oil Landfarm)	612	RCRA permit application submitted June 1993. No new wastes are being stored.
PCB and RCRA Hazardous Drum Storage Facility, Bldg. 9720-9 (eastern half)	Liquid and solid PCB waste	751	RCRA permit issued September 28, 1995 and TSCA permit approved September 24, 1991. Part of building included in mixed waste storage table.
PCB and RCRA Container Storage Area (Bldg. 9720-58)	Solid hazardous waste and mixed LLW	223	Permitted PCB waste materials. Mixed waste included in mixed LLW table. RCRA permit issued September 28, 1995.
RCRA Storage and Staging Area (Bldg. 9720-31)	Liquid and solid hazardous waste to include PCB-contaminated waste	170	RCRA permit issued September 28, 1995.

Source: DOE 1994n; OR DOE 1993a; OR DOE 1995g; OR MMES 1995c.

TABLE H.2.1–6.—*Low-Level Waste Treatment Capability at Oak Ridge National Laboratory*

Treatment Unit	Treatment Method(s)	Input Capability	Output Capability	Total Capacity (m^3/yr)	Comment
Waste Compactor Facility (Bldg. 7831)	Compaction	Compactible solid LLW	Compacted solid LLW in B-25 3x3x4.6 m (4x4x6 ft) boxes to K-25	11,300	Design capacity.
Liquid Low-Level Waste Evaporation Facility (Bldg. 2531)	Evaporation/drying	Liquid LLW and mixed LLW	Evaporator condensates to process waste treatment plant. Some evaporator bottoms are stored at Melton Valley Facility.	18	Normal operating capacity. Maximum capacity is 4,540 L/hr for 20 days per month.
Melton Valley LLW Immobilization Facility	Liquid decantation, ion exchange, and solidification	Liquid mixed LLW and nonhazardous waste	Concrete block	189	System is limited to 189,000 L (50,000 gal) per campaign.
Process Waste Treatment Plant (Bldg. 3544)	Ion exchange, neutralization, clarification, and filter presses	Liquid LLW and mixed LLW	Solid LLW (filter cake) to storage at K-25. Wastewater is sent to nonradiological wastewater treatment plant.	265,000	Normal operating capacity. Design capacity is 390,000 m^3/yr.

Source: DOE 1994k; DOE 1994n; DOE 1995gg.

TABLE H.2.1–7.—*Low-Level and Mixed Low-Level Waste Storage Capability at Oak Ridge National Laboratory*

Storage Unit	Input Capability	Total Capacity (m^3)	Comment
Buildings 7823B, 7823E, 7827, 7829, 7831C, 7878A, B7823C, B7823D	Solid LLW	903	No permit necessary.
Buildings 7842A and 7856	Solid remote-handled LLW	949	No permit necessary.
Bulk Contaminated Soil Facility (Bldg. 7576)	Low-level contaminated soil	938	Planned and funded.
Class L-III/IV Retrievable Storage Facilities	Class III and IV solid LLW	566	Planned and funded. RCRA Part B permit submitted March 30, 1992.
Facility 7841	LLW (contaminated scrap metal)	1,020	No permit necessary.
Liquid Low-Level Waste System	Liquid LLW and mixed LLW	3,230	Active portion has 1,970 m^3 of storage. Includes Melton Valley Storage Tanks, which have capacity of 1,510 m^3.
Long-Term Hazardous Waste Storage Facility (Bldg. 7654)	Solid and liquid mixed LLW	62	Interim Part A (included in Part B application) submitted January 14, 1993.
Mixed Waste Drum Storage Pad (Bldg. 7507W)	Liquid/solid mixed LLW	74	Interim Part B RCRA submitted May 21, 1992.
Scrap Metal Accumulations Area	Contaminated scrap metal	4,350	No permit necessary.
Storage Facility–semi-underground (Bldg. 7823)	Liquid/solid mixed waste oils, solvents, and other process	110	Interim Part A (included on Part B application).
Tank 7830A	Bulk mixed waste oils	19	Interim RCRA Part A (included in RCRA Part B application).

Source: DOE 1994n; OR DOE 1995g; OR MMES 1995c.

TABLE H.2.1–8.—*Low-Level Waste Disposal Units at Oak Ridge National Laboratory*

Disposal Unit	Input Capability	Capacity (m^3)	Comment
Asbestos silos (SWSA-6)	Low-level contaminated asbestos	22	Unit accepts only Y-12 asbestos, if contaminated with other than uranium contamination, other than that no offsite waste accepted. Closed at end of 1993. Capacity is amount stored.
Biological trenches (SWSA-6)	Low-level contaminated biological waste	106	Landfill operation. Closed at end of 1993. Capacity is amount stored.
High range silos (SWSA-6)	Solid LLW (200 mrem/hr to 1 rem/hr)	23	Concrete silos inside diameter (15 ft x 8 ft). Closed at end of 1993. Capacity is amount stored.
Interim Waste Management Facility	Solid LLW B-25 boxes encased in concrete	3,590	Four Tumulus pads (18.2 x 27.4 m). Fifth under construction. Each pad provides 897 m^3 for disposal.
Low range silos (SWSA-6)	Solid LLW (<200 mrem/hr)	204	Concrete silos inside diameter (15 ft x 8 ft). Closed at end of 1993. Capacity is amount stored.

Source: DOE 1994n; OR MMES 1993d; OR MMES 1995c.

TABLE H.2.1–9.—*Mixed Low-Level Waste at Oak Ridge National Laboratory*

Waste Matrix	Number of Waste Streams	Inventory as of December 31, 1994 (m^3)	Number of Waste Streams Five-Year Projection	Total Generation Five-Year Projection (m^3)
Contact-Handled				
Aqueous liquid/slurries	3	22	3	34
Organic liquids	4	61	3	62
Homogeneous solids	6	4	5	4
Solids/gravel	3	5	3	8
Debris waste	9	7	9	22
Labpacks	4	36	4	3
Special wastes	7	2	5	2
Other	3	39	3	33
Remote-Handled				
Aqueous liquid, alpha	1	2,780	None	532
Homogeneous solids	1	42	None	None
Total	42	2,998	36	700

Source: DOE 1995gg.

TABLE H.2.1–10.—*Hazardous Waste Treatment Capability at Oak Ridge National Laboratory*

Treatment Unit	Treatment Method(s)	Input Capability	Output Capability	Total Capacity[a]	Comment
Acid Neutralization Facility	Neutralization	Liquid blowdown and demineralizer regeneration from Steam Plant	Effluent to Nonradiological Wastewater Treatment Plant	44,900	Volume treated in 1992. Design feedrate is 23 m^3/hr.
Chemical Detonation Facility (Bldg. 7667)	Open burning	Solid and liquid explosive wastes (lab pack flammables)	Residue (ash) to Sludge Fixation Facility for treatment	Campaign	RCRA interim permit submitted January 14, 1993.
Leaking Gas Cylinder Area	Venting of damaged and excess gas cylinders	Hazardous gas cylinders	Returned to vendors or disposed of at Y-12 Plant Sanitary Landfill II	Campaign	Remote site consisting of clear area.
Non-Radiological Wastewater Treatment Plant (Bldg. 3608)	Clarification, filtering, air stripper, absorption, neutralization, dewatering, and ion exchange	Liquid corrosive waste in storage	Dewatered waste, carbon, liquid discharge	745,000	Normal operating capacity. Design capacity is 1,510,000 m^3/yr.

[a] For those facilities already in use, this is a normal operating capacity; for facilities under design or construction, this is a design capacity. Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds, results of treatability studies, and permit issuance.

Source: DOE 1994n; DOE 1995gg; OR DOE 1994a; OR MMES 1995c.

TABLE H.2.1–11.—*Hazardous Waste Storage Capability at Oak Ridge National Laboratory*

Storage Unit	Input Capability	Total Capacity (m^3)	Comment
Chemical Waste Storage Facility (Bldg. 7653)	Solid explosives, lab pack chemicals, and waste reactive metals	26	RCRA interim permit. Part A included on Part B application. Can be used for mixed waste. Permitted storage is 12 m^3.
Clean Oil Storage Pad (Bldg. 7651)	Clean oil	27	RCRA interim permit. Part A included on Part B application. Can be used for mixed waste. Permitted storage.
Hazardous Waste Storage Facility (Bldg. 7507)	Liquid PCB	31	RCRA interim permit. Part A included on Part B application. Can be used for mixed waste.
Hazardous Waste Storage Facility (Bldg. 7652)	Hazardous bulk liquids and solids	57	Final RCRA Part B September 1, 1986. Can be used for mixed wastes.

Source: DOE 1994n; OR MMES 1995c.

TABLE H.2.1–12.—*Low-Level, Mixed Low-Level, and Hazardous Waste Treatment Capability at K-25 Site*

Treatment Unit	Treatment Method(s)	Input Capability	Output Capability	Total Capacity (m^3/yr)	Comment
Central Neutralization Facility (K-1407H)	Clarification, thickening, and neutralization	Liquid LLW, mixed LLW, and hazardous waste	Liquid effluent through NPDES outfall and sludge to hazardous waste storage unit	221,000	RCRA permit-by-rule, NPDES permit. Permitted capacity. Normal operation capacity is 111,000 m^3/yr.
Liquid Pretreatment Facility	Neutralization, precipitation, liquid separation, and chemical oxidation/reduction	Liquid aqueous and organic mixed wastes.	Effluent to existing wastewater facilities or TSCA incinerator	Planned	Batch process
Sludge Fixation Facility (Bldg. K-1419)	Screening, solidification/stabilization, centrifuging, and neutralization	Mixed waste sludges and solids	Liquid effluent to Central Neutralization Facility. Solidified container stored at Concrete Block Casting and Storage Yard (Bldg. K-1417)	2.5 m^3/hr	Design feedrate RCRA permit submitted May 18, 1989. Facility on stand by.
TSCA Incinerator (K-1435)	Incineration (rotary kiln)	Liquid and solid - mixed LLW, LLW and mixed LLW contaminated with PCBs	Ash (solid mixed LLW and hazardous) to hazardous waste storage unit, WSU-012, ash water and blowdown water (mixed LLW and hazardous) to central neutralization facility, and sludge (solid mixed LLW) to sludge fixation facility	1860 (liquid only)	Final State CAA permit approved; state RCRA permit expires September 27, 1997 and TSCA permit expires March 20, 1992. Site given continued authority to operate an old TSCA permit for air and normal operating capacity. Maximum capacity is 15,700 m3/yr.
Wastewater Treatment Facility (K-1232)	Centrifugation, neutralization, and precipitation	Liquid mixed LLW	Leachate (liquid LLW) to central neutralization facility and sludge (solid mixed LLW) to sludge fixation facility	0.8m^3/hr	RCRA permit submitted May 18, 1989. Design feedrate. Facility not currently being utilized.

Source: DOE 1994n; DOE 1995gg; OR DOE 1994a.

TABLE H.2.1–13.—*Low-Level, Mixed Low-Level, and Hazardous Waste Storage Capability at K-25 Site* [Page 1 of 4]

Storage Unit	Input Capability	Total Capacity[a] (m^3)	Comment
Buildings K-1232, K-305-12, K306-4	Mixed LLW and LLW	688	Permitted.
Buildings K-1417 and K-1419	Mixed waste (sludge)	27,100	Under RCRA closure. Pond Waste Management Project storage facility for pond waste sludge.
Combustible Liquid Storage Tanks (K-1202)	Liquid LLW, mixed LLW, and hazardous waste	108	RCRA permit expires September 1, 2002. Two bulk storage tanks.
Flammable Liquid Storage Unit (K-1420A)	Liquid mixed LLW, PCB waste, and hazardous waste	108	RCRA permit expires September 1, 2002. Two bulk storage tanks.
Hazardous Waste Storage Unit (K-311-1)	Solid mixed LLW and hazardous waste	456	RCRA permit expires September 1, 2002. Vault for radiogenic lead waste.
Hazardous Waste Storage Unit (K-310-1)	Liquid and solid LLW, mixed LLW, hazardous, and non-RCRA waste	445	RCRA permit expires September 1, 2002. RCRA sludges and ash from operation of K-1035 incinerator. No remaining capacity as of August 1994.
Hazardous Waste Storage Unit (Vault 2A)	Liquid and solid LLW, mixed LLW, hazardous, and non-RCRA waste	439	RCRA permit expires September 1, 2002. Practical capacity.
Hazardous Waste Storage Unit (K-309-3)	Liquid and solid LLW, mixed LLW, hazardous, and non-RCRA waste	416	RCRA permit expires September 1, 2002. Has been used for RCRA, PCB, and mixed wastes from all sites at ORR.
Hazardous Waste Storage Unit, (K-301-1, Vault 4)	Liquid and solid LLW, mixed LLW, hazardous, and non-RCRA waste to include PCBs	431	RCRA permit expires September 1, 2002. Storage of laboratory waste acids, bases, and organics.
Hazardous Waste Storage Unit, (K-301-1, Vault 4A)	Liquid and solid LLW, mixed LLW, hazardous, and non-RCRA waste to include PCBs	637	RCRA permit expires September 1, 2002. Waste consists of sludges and incinerator ash.
Hazardous Waste Storage Unit, (K-301-2, Vault 4B)	Liquid and solid LLW, mixed LLW, hazardous, and non-RCRA waste to include PCBs	380	RCRA permit expires September 1, 2002. Waste consists primarily of photographic waste and incinerator ash.
Hazardous Waste Storage Unit, (K-302-4)	Liquid and solid LLW, mixed LLW, hazardous, and non-RCRA waste to include PCBs	503	RCRA permit expires September 1, 2002. Storage of PCB organics and mercury-contaminated organics.
Hazardous Waste Storage Unit, (K-302-5, Vault 8A)	Liquid and solid LLW, mixed LLW, hazardous, and non-RCRA waste to include PCBs	635	RCRA permit expires September 1, 2002. Storage of hazardous wastes from K-25 and Y-12.
Hazardous Waste Storage Unit, (K-302-5)	Liquid and solid LLW, mixed LLW, hazardous and non-RCRA waste to include PCBs	464	RCRA permit expires September 1, 2002. Storage of RCRA and mixed wastes from K-25 and Y-12.

TABLE H.2.1–13.—*Low-Level, Mixed Low-Level, and Hazardous Waste Storage Capability at K-25 Site* [Page 2 of 4]

Storage Unit	Input Capability	Total Capacity[a] (m^3)	Comment
Hazardous Waste Storage Unit (K-303-1)	Liquid and solid mixed LLW, mixed LLW, hazardous and non-RCRA waste to include PCBs	592	RCRA permit expires September 1, 2002.
Hazardous Waste Storage Unit (K-303-2)	Liquid and solid mixed LLW, mixed LLW, hazardous and non-RCRA waste to include PCBs	496	RCRA permit expires September 1, 2002.
Hazardous Waste Storage Unit (Bldg. K-305-6, Vault 19A)	Liquid and solid mixed LLW, LLW, hazardous and non-RCRA waste to include PCBs	592	RCRA permit expires September 1, 2002.
Hazardous Waste Storage Unit (K-305-6)	Liquid and solid LLW, mixed LLW, hazardous and non-RCRA waste to include PCBs	354	RCRA permit expires September 1, 2002.
Hazardous Waste Storage Unit (K-305-12)	Liquid and solid mixed LLW, LLW, hazardous and non-RCRA waste to include PCBs	789	RCRA permit expires September 1, 2002. Includes 3 m^3 of LLW and/or contaminated scrap metal as of June 1994.
Hazardous Waste Storage Unit (K-306-1)	Liquid and solid LLW, mixed LLW, hazardous and non-RCRA waste to include PCBs	224	RCRA permit expires September 1, 2002. Sludges generated during treatment of Y-12 wastewaters.
Hazardous Waste Storage Unit (Vault 23A)	Liquid and solid LLW, mixed LLW, hazardous and non-RCRA waste to include PCBs	429	RCRA permit expires September 1, 2002. Sludge generated during treatment of Y-12 wastewaters at either K-1232 of Y-12 facilities.
Hazardous Waste Storage Unit (K-306-3)	Liquid and solid LLW, mixed LLW, hazardous and non-RCRA waste to include PCBs	369	RCRA permit expires September 1, 2002. Storage of RCRA, PCB, and mixed wastes from K-25, Y-12, and ORNL.
Hazardous Waste Storage Unit (K-306-4, Vault)	Liquid and solid mixed LLW, mixed LLW hazardous and non-RCRA waste to include PCBs	399	RCRA permit expires September 1, 2002. Mixed waste.
Hazardous Waste Storage Unit (Vault 25A)	Liquid and solid mixed LLW, LLW, hazardous and non-RCRA waste to include PCBs	1,030	RCRA permit expires September 1, 2002.
Hazardous Waste Storage Unit (K-1036-A)	Liquid and solid LLW, mixed LLW, hazardous and non-RCRA waste to include PCBs	150	RCRA permit expires September 1, 2002. Used for solvents and waste oil storage. Oil may be contaminated. Maximum capacity 2,000 55-gal drums.
Hazardous Flammable Waste Storage Unit (K-711)	Liquid and solid LLW, mixed LLW, hazardous and non-RCRA waste to include PCBs	312	RCRA permit expires September 1, 2002. Waste oils and solvents generated at other DOE facilities. Maximum capacity of 1,800 55-gal drums.

TABLE H.2.1–13.—*Low-Level, Mixed Low-Level, and Hazardous Waste Storage Capability at K-25 Site* [Page 3 of 4]

Storage Unit	Input Capability	Total Capacity[a] (m^3)	Comment
Hazardous Waste Storage Unit (K-1025C)	Liquid and solid LLW, mixed LLW, hazardous and non-RCRA wastes	9	RCRA permit expires September 1, 2002. No incompatibles. Used for out-of-date or off-specification laboratory chemicals disposed through offsite commercial facilities.
Hazardous Waste Storage Unit (K-1302)	LLW, mixed LLW, hazardous, and non-RCRA compressed gas	3	RCRA permit expires September 1, 2002. Gases are commercial products that are to be discarded or treated.
K-31 WP (stabilized sludge storage)	Hazardous/mixed waste	8,000	RCRA permit expires July 1, 2023. Storage of solidified pond waste sludge from closure of K-1407B and -C ponds. Design capacity is 8,000 m^3.
K-33 WP (stabilized sludge storage)	Mixed LLW	8,510	Permitted. Storage of solidified pond waste sludge from closure of K-1470B and -C ponds. Material continues to be shipped offsite for disposal.
K-301-4, K-25 Building, one unnamed Vault	Solid hazardous/mixed waste	377	Permitted Part B.
K 303-3/Vault 10A, 11A	Solid LLW and mixed LLW	10,400	Permitted. Includes contaminated scrap metal. Awaiting letter of approval from state before use as hazardous waste storage facility.
K-306-IT, Bldg. K-25 (Vault)	Liquid/solid mixed waste	156	Permit not necessary.
K-310-3, Vault in Building K-25	Hazardous/mixed waste	527	RCRA permit expires September 1, 2002. New facility. Awaiting letter of approval from State before use as a hazardous waste storage facility.
K-402-1 Process Vault and Vault 31X, Building K-27	Hazardous/mixed waste	765	RCRA permit expires September 2002. Formerly LLW storage unit. Awaiting letter of approval from State before use as a hazardous waste storage facility.
K-1065-A, -B, -C, -E	Mixed waste/sludge	4,680	RCRA permit expires 2023. Pond Waste Management Project storage units for pond waste sludge.
RCRA Storage Unit, Vault 3A	Liquid and solid LLW and hazardous wastes	326	RCRA final permit expires 2002. Will be used for RCRA and mixed wastes from K-25, Y-12, and ORNL. Currently, empty PCB-contaminated containers from K-25 and Y-12 being stored in vault.
TSCA Container and Tank Storage (K-1435)	Non-PCB contaminated flammable liquid and mixed low-level that is also PCB-contaminated	527	TSCA incinerator has three storage areas. The Tank Farm has 3 10,000-gal and 12 5,000-gal tanks for liquid only. Area B (TSCA waste) can store 352 55-gal drums and Area C (RCRA waste) can store 496 55-gal drums. Part B permitted.
TSCA Storage Unit (K-33)	Liquid and solid hazardous waste (PCB)	960	No permit required.
TSCA Storage Unit (K-726)	Liquid and solid - LLW and non-RCRA, nonradioactive waste contaminated with PCBs	94	No permit required to store waste when covered under TSCA. Concrete block building - PCB waste.

TABLE H.2.1–13.—*Low-Level, Mixed Low-Level, and Hazardous Waste Storage Capability at K-25 Site* **[Page 4 of 4]**

Storage Unit	Input Capability	Total Capacity[a] (m^3)	Comment
TSCA Storage Unit (K-303-4)	Liquid and solid - LLW and non-RCRA, nonradioactive waste contaminated with PCBs	583	No permit necessary.
Vault 5A, Bldg. K-25	Solid hazardous/mixed LLW	535	Permitted. Awaiting letter of approval from state before use as a hazardous waste storage facility.
Vault 24A, K-306-4	Solid hazardous/mixed LLW	292	Permitted. New facility. Awaiting letter of approval from state before use as a hazardous waste storage facility.
Waste Oil/Hazardous Wastes Storage I (K-1425 containers)	Liquid and solid LLW and mixed LLW	85	RCRA Part B permit issued September 30, 1992. Wastes stored include oils, solvents, water, and organics. Max. capacity is 480 55-gal drums.
Waste Oil/Hazardous Wastes Storage II (K-1425 tanks)	Liquid LLW and mixed LLW	343	RCRA Part B permit issued September 30, 1992. Wastes stored include oils, solvents, water, and organics. Four 22,500-gal tanks.

[a] Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds, results of treatability studies, and permit issuance. These capacities are the practical capacity rather than the design capacity.

Source: DOE 1994n; OR DOE 1993a; OR DOE 1995g; OR MMES 1993e; OR MMES 1995c; ORR 1993a:11.

TABLE H.2.1–14.—*Low-Level Waste Storage Capability at K-25 Site*

Storage Unit	Input Capability	Total Capacity[a] (m^3)	Comment
Contaminated Scrap Metal Yard (K-770)	Solid LLW (uranium-contaminated scrap metal, ferrous and nonferrous)	202,000	6.9 acres of contaminated scrap metal. Design capacity. As of June 1994, 29,600 m^3 of LLW can be stored. Responsibility for facility transferred to Environmental Restoration in 1994 and is no longer available for LLW storage.
K-33 LLW Drum and Container Facilities	Liquid/solid LLW	3,110	No permit necessary.
K-1313A (Rubb Tents I, II)	Solid LLW	246	Permit not necessary. Used to store Y-12, ORNL, and K-25 LLW.
LLW Storage Unit (K-310-2)	Liquid and solid LLW	654	Used for radioactively contaminated waste generated at ORNL.
LLW Storage Unit (K-309-2)	Liquid and solid LLW, non-RCRA, and nonradioactive (soils and metals)	663	Used for radioactively contaminated waste from K-25.
LLW Storage Unit (K-303-5)	Liquid and solid LLW	470	RCRA permit expires September 1, 2002. Construction upgrades required before storage of mixed waste. Used for radioactively contaminated waste from K-25, Y-12 and ORNL.
LLW Storage Unit (Vault 15A)	Solid LLW	564	RCRA interim status September 1, 1990. Construction upgrades required before storage of mixed waste. Used for radioactively contaminated waste from K-25, Y-12 and ORNL.
LLW Storage Unit (K-306-2)	Solid LLW	396	Used for radioactively contaminated soil from Y-12. As of June 1994, 246 m^3 of LLW can be stored.
LLW Storage Unit (K-306-7)	Liquid and solid LLW	343	Used for radioactively contaminated soil from Y-12. As of June 1994, 314 m^3 of LLW can be stored.
LLW Storage Unit (K 1066-H)	Solid LLW (containerized)	4,730	Outdoor storage area.
Vault 6 (K-25 building)	Solid LLW	269	No permit necessary.

[a] Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds and permit issuance.

Source: DOE 1994n; OR DOE 1993a; OR DOE 1995g; OR MMES 1995c.

TABLE H.2.1–15.—*Mixed Low-Level Waste at K-25 Site*

Waste Matrix	Number of Waste Streams	Inventory as of December 31, 1994 (m^3)	Number of Waste Streams Five-Year Projection	Total Generation Five-Year Projection (m^3)
Contact-Handled				
Aqueous liquids/slurries	5	442	5	169
Organic liquids	6	348	4	118
Homogeneous solids	15	27,800	8	1,380
Soils/gravel	4	272	3	49
Debris waste	12	386	12	317
Labpacks	2	22	2	5
Special waste	7	117	4	10
Other	3	66	1	1
Total	54	29,453	39	2,049

Source: DOE 1995gg.

H.2.2 Savannah River Site

The process of manufacturing useful nuclear materials has produced radioactive, mixed, and hazardous wastes that are treated, stored, or disposed of at SRS. The *Savannah River Site Waste Management Final Environmental Impact Statement* (DOE/EIS-0217, July 1995) addressed the tasks to be completed in the next 10 years to clean up existing waste units and bring current operations into compliance with applicable regulations. The EIS discusses the current conditions and provides DOE's preferred alternatives for processing current and future waste streams. It also addresses the development and funding of processes to minimize waste generation and to safely process and dispose of future waste generation. Because there is no spent nuclear fuel associated with the fabrication of primaries, there will be no further discussion of spent nuclear fuel at SRS.

Pollution Prevention. Pollution prevention, previously driven by best management practices and economics, is now mandated by statutes, regulations, and agency directives. The SRS Waste Minimization and Pollution Prevention Program is designed to achieve a continuous reduction of wastes and pollutant releases to the maximum extent feasible in accordance with regulatory requirements while fulfilling national security missions. The SRS Waste Minimization and Pollution Prevention Awareness Plan addresses wastes and potential pollutants of all types and establishes priorities for accomplishing waste minimization and pollution prevention through source reduction, recycling, treatment, and environmentally safe disposal.

High-Level Waste. Liquid HLW containing actinides and hazardous chemicals was generated from recovery and purification of TRU products and from spent fuel processing, and is retrievably stored in 51 underground tanks. One of these tanks is out of service. The tanks are managed in compliance with Federal laws, State of South Carolina regulations, and DOE orders. The waste is segregated by heat generation rate, neutralized to excess alkalinity, and stored to permit the decay of short-lived radionuclides before its volume is reduced by evaporation. Of the 51 tanks, 29 are located in the H-Area Tank Farm, and 22 are located in the F-Area Tank Farm. The tanks are of four different designs, but all are of carbon steel. Newer tanks which have full height secondary containment and forced water cooling are used for waste processing. Some older tanks contain salt and sludge awaiting waste removal. Old tanks that have had waste removed except for residue are used to store low-activity waste. The older tanks will be taken out of service when space in other tanks becomes available due to transfer to the Defense Waste Processing Facility.

High-heat liquid waste is stored for 1 to 2 years to allow decay of radionuclides before being processed through evaporators. Low-heat waste is sent directly to the evaporator feed tanks. Each tank farm has one evaporator that is used to reduce the volume of the water and concentrate the solids. A replacement higher capacity evaporator is planned that may be used in conjunction with the current evaporators. Liquids can be reduced to 25 to 33 percent of their original volume and stored as salts or sludges. Cesium removal columns can operate in conjunction with the evaporators. The evaporators obtain decontamination factors of 10,000 to 100,000 and the cesium removal columns can obtain another 10 to 200 decontamination factors. Decontaminated liquids (overheads) are sent to the Effluent Treatment Facility for processing before being released to Upper Three Runs Creek. The concentrated salt solution is processed to remove radionuclides, and the decontaminated solution is sent to the Defense Waste Processing Facility Saltstone Facility for solidification and onsite storage in the Saltstone Vaults.

The remaining sludges and salts contain the majority of the radionuclides and are stored separately awaiting vitrification. Prior to vitrification, salt would be precipitated in the in-tank precipitation process. The precipitate and sludge would be fed into the vitrification process in the Defense Waste Processing Facility. The waste would be mixed with borosilicate glass and immobilized by melting and then pouring the mixture into stainless steel cylinders. These cylinders would be stored in a shielded facility at the Defense Waste Processing Facility until a repository is available. Figure H.2.2–1 illustrates HLW management at SRS. Tables H.2.2–1, H.2.2–2, and H.2.2–3 list HLW inventories and treatment and storage facilities at SRS.

Transuranic Waste. All TRU waste currently being generated is stored in containers on aboveground storage pads in compliance with state regulations and DOE orders. Older TRU wastes (prior to 1965) were

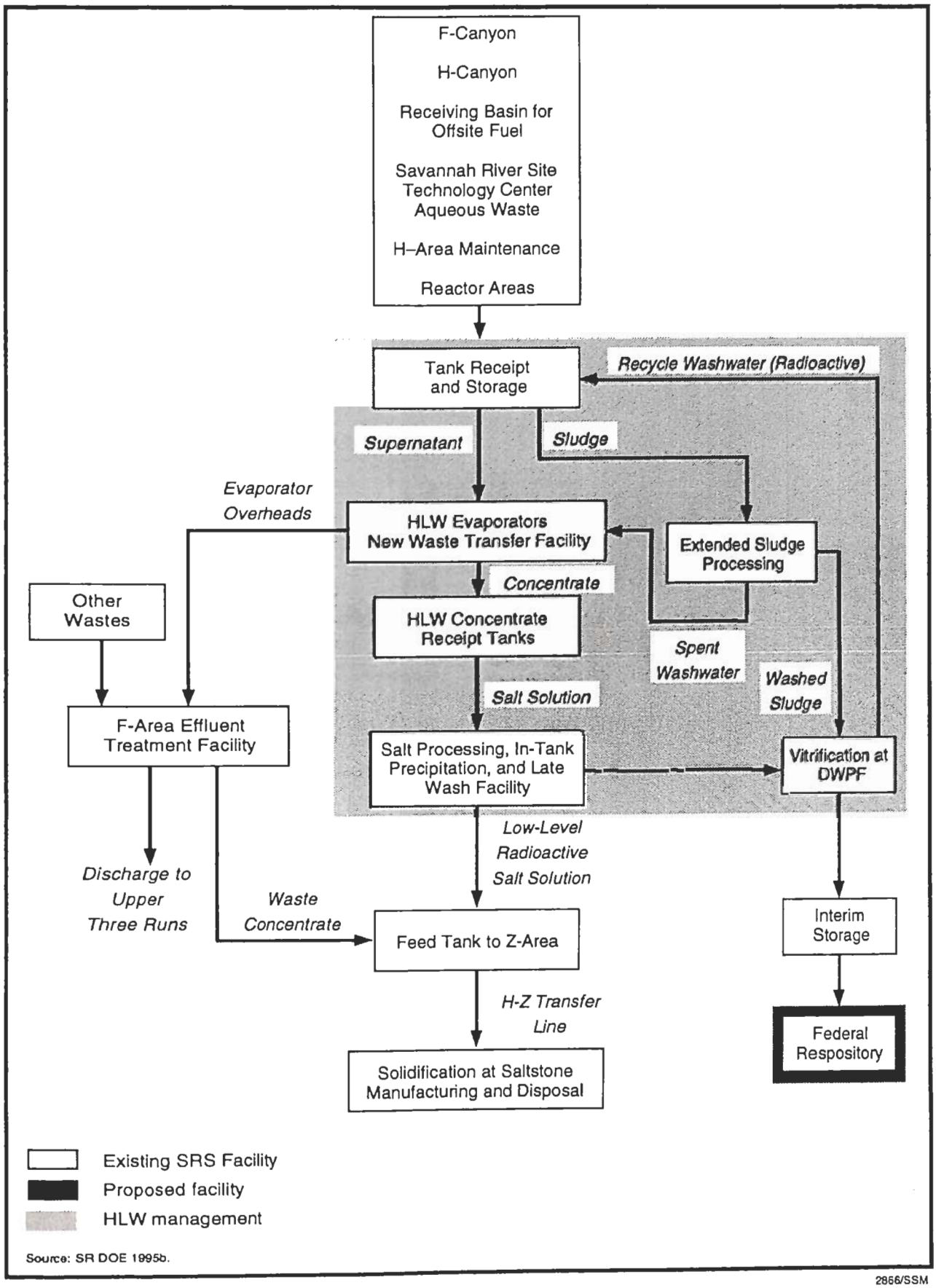


FIGURE H.2.2–1.—*High-Level Waste Management Plan at Savannah River Site.*

TABLE H.2.2–1.—*High-Level Wastes at Savannah River Site*

Waste Matrix	Number of Waste Streams	Inventory as of September 30, 1994 (m^3)	Number of Waste Streams Five-Year Projection	Total Generation Five-Year Projection (m^3)
Remote-Handled				
Aqueous liquids, slurries	2	127,040	2	15,430

Source: SR DOE 1995c; WSRC 1995a.

TABLE H.2.2–2.—*High-Level Waste Treatment Capability at Savannah River Site*

Treatment Unit	Treatment Method	Input Capability	Output Capability	Total Capacity[a] (m^3 per year)	Comment
F- and H-Tank Farms	Neutralization dissolution and chemical reaction	HLW aqueous liquid solutions and slurries	HLW aqueous liquid, sludge, and solutions	[b]	Operational
Savannah River Technology Center high activity treatment probe	Ion exchange	HLW aqueous liquid	Mixed LLW liquid and HLW sludge	1,725	Operational
F- and H-evaporators	Evaporation and ion exchange (cesium removal)	HLW aqueous liquid	HLW sludge, salt, slurry, and organic solid	26,900[c]	Operational
Replacement evaporator	Evaporation and ion exchange (cesium removal)	HLW aqueous liquid	HLW sludge, salt, slurry, and organic solid	13,800	Design and construction phase planned for 1999
Defense Waste Processing Facility	Vitrification	HLW and precipitate slurry	HLW borosilicate	18,800	Operational
Extended sludge processing	Soil washing to remove soluble salts, precipitation	HLW sludge	HLW sludge	834	Operational
In-tank precipitation	Soil washing to remove soluble salts, precipitation	HLW salt solution	LLW salt solution and HLW precipitate slurry	Would produce 22,700 m^3 salt solution and 1,900 m^3 precipitate	Operational
Late wash	Washing to remove sodium nitrate	HLW precipitate slurry	HLW precipitate	24,600	Undergoing design and construction

[a] For those facilities already in use, this is a normal operating capacity; whereas, for facilities under design or construction, this is a design capacity. Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds, results of treatability studies, and permit issuance.

[b] Batch process; depends on available tanks and process used.

[c] Based on net tank space gained. Input volume.

Source: SR DOE 1994b; SR DOE 1995b; SR DOE 1995c; WSRC 1995a; WSRC 1995b.

TABLE H.2.2–3.—*High-Level Waste Storage at Savannah River Site*

Storage Unit	Input Capability	Total Capacity[a]	Comment
F- and H-Area Tank Farms[b]	HLW, corrosive, toxic aqueous liquids, salt, and sludge	145,000 m^3	Operational
Defense Waste Processing Facility vitrification plant, glass waste storage buildings	HLW solid borosilicate glass in stainless steel cylinders	2,286 canisters (3.8 t glass)	First unit available December 31, 1995, one building constructed, one more planned
Defense Waste Processing Facility vitrification plant, failed equipment storage	Failed melters	3,720 m^3	

[a] Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds and permit issuance.

[b] Tanks that do not meet secondary containment criteria as described in the Federal Facility Compliance Agreement are not included.

Source: SR DOE 1994b; SR DOE 1995c.

buried in plastic bags and cardboard boxes in earthen trenches. Wastes containing more than 0.1 curies (Ci) per package were placed in concrete containers and buried. Wastes containing less than 0.1 Ci per package were buried unencapsulated in earthen trenches. Since 1974, TRU wastes containing more than 10 nCi/g have been stored in retrievable containers free of external contamination. Polyethylene-lined galvanized drums containing more than 0.5 Ci are additionally protected by closure in concrete culverts.

Currently, approximately 85 percent of the TRU waste in storage is suspected of being contaminated with hazardous constituents. Presently, waste is characterized by onsite generators and is being stored prior to final disposal. TRU waste containing less than 100 nCi/g may be disposed of as LLW at SRS. Waste containing greater than 100 nCi/g and meeting the final WIPP Waste Acceptance Criteria will be sent to WIPP, if it is determined to be a suitable repository pursuant to the requirements of 40 CFR 191 and 40 CFR 268. Waste not meeting the acceptance criteria as currently packaged will be repackaged as necessary to meet the WIPP Waste Acceptance Criteria. If additional treatment is necessary for disposal at WIPP, SRS would develop the appropriate treatment technology, or ship this waste to another facility for treatment. Studies are underway to solve the problem of high-heat TRU waste, which is unique to SRS. Wastes with high plutonium-238 fractions generate too much heat to be shipped in the Transuranic Package Transporter (TRUPACT)-II container. TRU waste is currently stored on 17 pads at the Solid Waste Disposal Facility in E-Area. The TRU waste management plan is illustrated in figure H.2.2–2. Table H.2.2–4 lists the mixed TRU waste inventories. Tables H.2.2–5 and H.2.2–6 present the TRU and mixed TRU waste treatment and storage facilities.

Low-Level Waste. Both liquid and solid LLW are treated at SRS. Liquids are managed and processed to remove and solidify the radioactive constituents and to release the balance of the liquids to permitted discharge points in compliance with state regulations. The bulk of liquid waste is aqueous process waste including effluent cooling water, purge water from storage basins for irradiated reactor fuel or target elements, distillate from the evaporation of process waste streams, and surface water runoff from areas where there is a potential for radioactive contamination. Aqueous LLW streams are sent to the Effluent Treatment Facility where they are 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 resultant wastes are concentrated by evaporation and stored in the H-Area Tank Farm prior to treatment in the Defense Waste Processing Facility Saltstone Facility. In that facility, they are processed with grout for onsite disposal. Figure H.2.2–3 illustrates the LLW processing at SRS. Treatment and storage facilities for LLW are listed in tables H.2.2–7 and H.2.2–8.

Disposal of solid LLW at SRS traditionally has been accomplished using engineered trenches in accordance with the guidelines and technology existing at the time of disposal. Currently, packaged LLW is deposited in the E-Area vaults, which are concrete structures that meet the requirements of DOE orders, incorporate technological advances, and address more stringent Federal regulations and heightened environmental awareness. Four basic types of vaults/buildings are utilized for the different waste categories: low-activity waste vault, intermediate-level nontritium vault, intermediate-level tritium vault, and long-lived waste storage building. The vaults are below-grade concrete structures, and the storage building is a metal building on a concrete pad. Long-lived waste is being stored until a final disposition can be determined. Additional information on these facilities is given in table H.2.2–9.

Solid LLW is segregated into several categories to facilitate proper treatment, storage, and disposal. Solid LLW that radiates less than 200 mrem per hour at 5 centimeters (cm) (1.97 inch [in]) from the unshielded container is considered low-activity waste. If it radiates greater than 200 mrem per hour at 5 cm (1.97 in), it is considered intermediate-activity waste. This waste is typically contaminated equipment from separations, reactors, or waste management facilities. Intermediate-activity tritium waste is intermediate-activity waste with greater than 10 Ci of tritium per container. Spent lithium-aluminum targets from tritium operations equipment is included in this waste. Long-lived waste is contaminated with long-lived isotopes that exceed the waste acceptance criteria for disposal. Resin contaminated with carbon 14 from reactor operations is an example. Excavated soil from radiological materials areas that is potentially contaminated and cannot be economically demonstrated to be uncon-

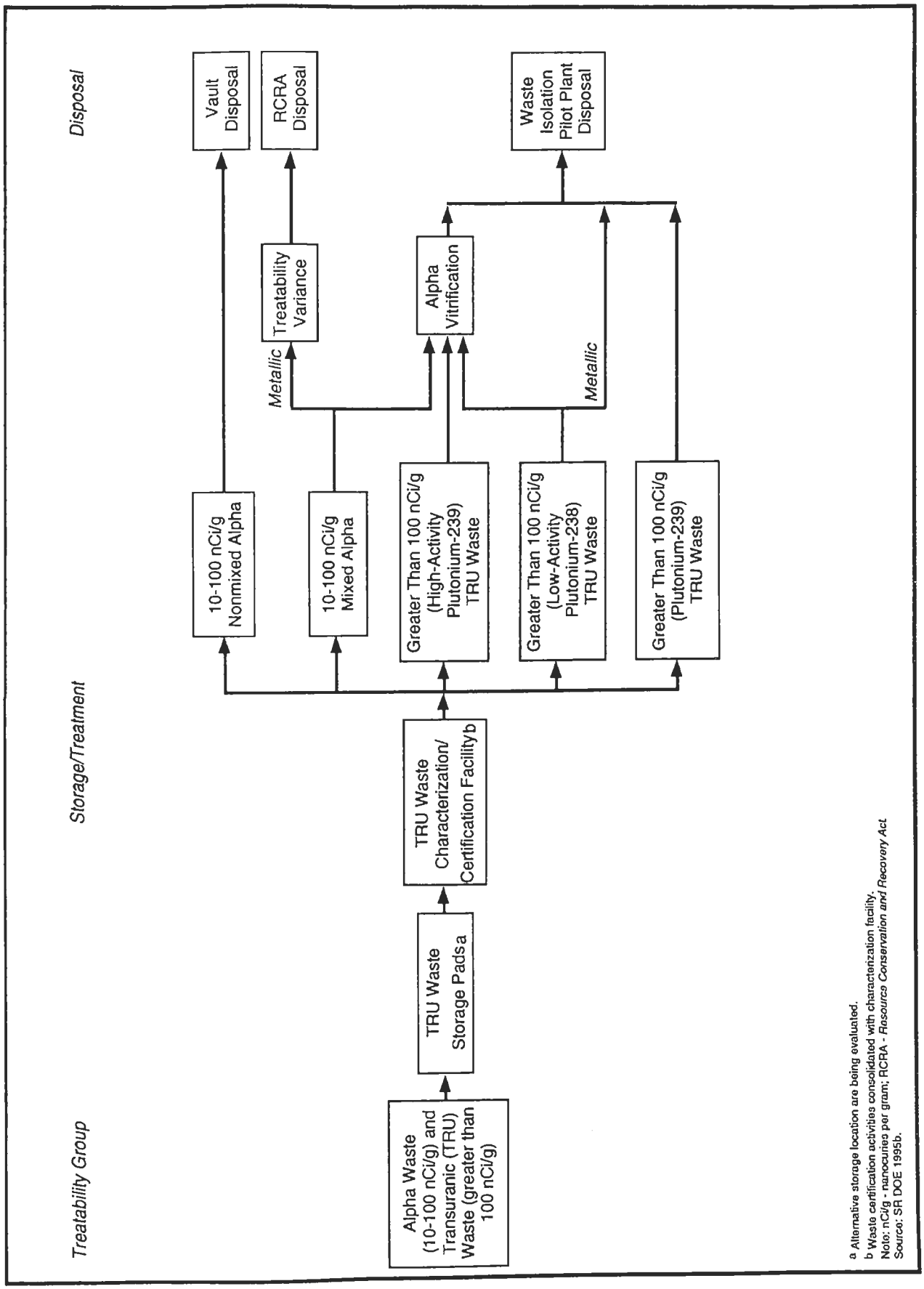


FIGURE H.2.2-2.—*Transuranic Waste Management Plan at Savannah River Site.*

TABLE H.2.2–4.—*Transuranic and Mixed Transuranic Waste at Savannah River Site*

Waste Matrix	Number of Waste Streams	Inventory as of September 30, 1994 (m^3)	Number of Waste Streams Five-Year Projection	Total Generation Five-Year Projection (m^3)
Contact-Handled				
Organic liquids	1	<1	0	0
Combustible debris	3	7,693	1	240
Debris	2	199	2	2,613
Ash	1	<1	0	0
Total	5	8,162	1	2,853

Source: DOE 1995gg; WSRC 1995a.

TABLE H.2.2–5.—*Transuranic and Mixed Transuranic Waste Treatment Capability at Savannah River Site*

Treatment Unit	Treatment Method	Input Capability	Output Capability	Total Capacity[a]	Comment
TRU Waste Characterization/ Certification Facility	Assaying, sorting, decontamination, size reduction, welding, venting, and encapsulation	Mixed and nonmixed TRU wastes	Certified forms for disposal	1,720 m^3/yr	Begin operations in 2007
Alpha vitrification	Vitrification	TRU and mixed TRU waste	Certified and stabilized forms for disposal	559 m^3/yr liquid or 2,280 m^3/yr solid	Planned

[a] For facilities under design or construction this is a design capacity. Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds, results of treatability studies, and permit issuance.

Source: SR DOE 1995c; WSRC 1995a; WSRC 1995b.

TABLE H.2.2–6.—*Transuranic and Mixed Transuranic Waste Storage at Savannah River Site*

Storage Unit	Input Capability	Total Capacity (m^3)	Comment
TRU storage pads	Miscellaneous solid TRU waste, extraction procedure toxic, listed	34,400	Operational RCRA Part A. No offsite waste planned. Buried waste to be exhumed, processed at TRU Waste Facility, and shipped to WIPP. Nineteen pads in use, 10 additional pads planned.

Source: SR DOE 1995c; WSRC 1995a; WSRC 1995b.

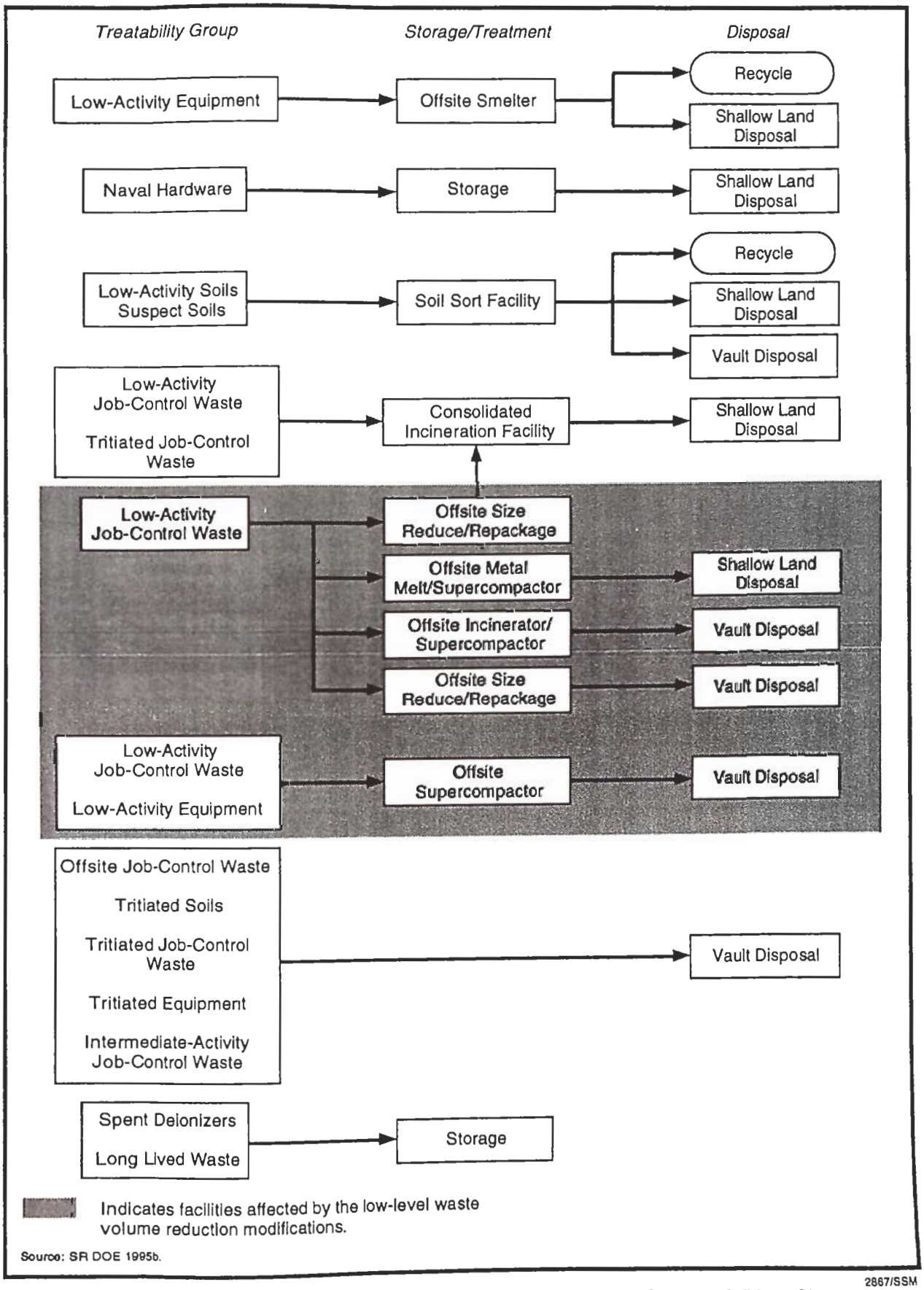


FIGURE H.2.2–3.—*Low-Level Waste Management Plan at Savannah River Site.*

TABLE H.2.2–7.—*Low-Level and Mixed Low-Level Waste Treatment Capability at Savannah River Site* [Page 1 of 2]

Treatment Unit	Treatment Method	Input Capability	Output Capability	Total Capacity[a] (m^3 per year)	Comment
Consolidated Incineration Facility and Ashcrete Stabilization Facility	Incineration/stabilization	LLW, mixed LLW, liquid, solid, ash, and slurry	Stabilized LLW, mixed LLW, and solid waste	4,630 (liquid) 17,830 (solid)	Planned, approved, RCRA final, available 1996
F- and H-Areas Effluent Treatment Facility	Neutralization, chemical precipitation, filtration, carbon adsorption, reverse osmosis, ion exchange, evaporation, and mercury adsorption	Mixed LLW, aqueous liquids (F- and H- area wastewater, evaporator overheads and condensate, and cesium removal column effluent)	Corrosive LLW liquid concentrate, treated water effluent used activated carbon, and used ion exchange resins (solid LLW)	1,930,000	Operational, NPDES operating
M-, L-, and H-Area compactors	Compaction	Solid LLW job waste	Compacted LLW	3,983	Operational
Hazardous/Mixed Waste Containment Building	Physical and chemical decontamination, wet chemical oxidation, encapsulation, and amalgamation	Liquids and solids, mixed LLW, toxic, corrosive, reactive, metal, sludge, and debris	Containment facility	703	Planned, approved, begin operation in 2006
Low-level waste smelter	Offsite decontamination	LLW and equipment	Recovered metal	600	Offsite facility
Non-alpha vitrification facility	Sorting and vitrification	LLW, mixed LLW, and hazardous wastes	Mixed LLW	3,090	Proposed facility
Offsite mixed waste treatments	Amalgamation, PCB destruction, acid bath, and smelting	Mixed LLW	Solid LLW	124	Offsite facilities
M-area Liquid Effluent Treatment Facility	Filtration, flocculation neutralization, and precipitation	Liquid mixed LLW	Wastewater, solid mixed LLW, and sludge	999,000	Operational, NPDES: operating
M-Area Vendor Treatment Facility	Vitrification	Aqueous liquids and slurries, mixed LLW, and sludges	Wastewater, solid mixed LLW, and borosilicate glass	2,470	Planned, approved, contract awarded for construction NPDES
Savannah River Technology Center ion exchange treatment probe low activity	Ion exchange	Mixed LLW and aqueous liquids	Aqueous liquid, solid, and mixed LLW	11,200	Operational, RCRA: interim
Soil Sort Facility	Sorting and separating contaminated soils	LLW soil	Low-level contaminated and uncontaminated soil	2,540	Proposed facility
Offsite supercompactor	Compaction	Solid LLW	Compacted solid LLW	42,400	Commercial facilities
Onsite supercompactor	Compaction	Solid LLW	Compacted solid LLW	5,700	Proposed facility

TABLE H.2.2–7.—*Low-Level and Mixed Low-Level Waste Treatment Capability at Savannah River Site* [Page 2 of 2]

Treatment Unit	Treatment Method	Input Capability	Output Capability	Total Capacity[a] (m^3 per year)	Comment
Z-Area Saltstone Facility	Stabilization (solidification with radionuclide binders)	Liquids, mixed LLW, sludges, toxic, corrosive	Solid LLW, nonhazardous	28,400	Operational, permitted disposal, CWA, RCRA: final

[a] For those facilities already in use, this is a normal operating capacity; whereas, for facilities under design or construction, this is a design capacity. Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds, results of treatability studies, and permit issuance.

Source: SR DOE 1995c; WSRC 1995a.

TABLE H.2.2–8.—*Low-Level and Mixed Low-Level Waste Storage at Savannah River Site*

Storage Unit	Input Capability	Total Capacity[a] (m^3)	Comment
Burial ground solvent tanks (S23-30)	Liquid mixed LLW	727	To be closed, RCRA Part A
Defense Waste Processing Facility organic waste storage tank (430-S)	Liquid mixed LLW, ignitable, toxic	568	Operational, RCRA Part A
Liquid waste solvent tanks (S33-36)	Liquid mixed LLW	454	Planned facility
M-Area Process Waste Interim Treatment/Storage Facility	Liquid mixed LLW, listed, (electroplate sludge)	8,300	Operational, RCRA Part A
Mixed waste storage buildings (643-29E and 643-43E)	Liquid mixed LLW solid, toxic, listed, ignitable, metal, sludge, soil	1,300	Operational, RCRA Part A
Mixed waste storage shed (316-M)	Liquid and solid mixed LLW	120	Operational, RCRA Part A
Savannah River Laboratory high activity storage tanks (772-2A)	Liquid mixed LLW, toxic, toxicity characteristic teaching procedure	198	Operational, RCRA Part A
Hazardous Waste Storage Facility (645-2N)	Mixed LLW	580	Operational, RCRA Part B
Process waste interim treatment	Liquid mixed LLW	8,300	Operational, RCRA Part A
Long-lived waste storage buildings	Process water deionizers containing carbon 14	3,330	Planned facility

[a] Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds and permit issuance.

Source: WSRC 1995a.

TABLE H.2.2–9.—*Waste Disposal at Savannah River Site*

Disposal Unit	Input Capability	Capacity[a,b] (m^3)	Comment
Hazardous/mixed waste disposal vaults	Solid mixed LLW and listed (CIF, Ashcrete, blowdown, and vitrified)	45,600	10 vaults are planned and funded, RCRA submitted 1990, available 2002.
Intermediate-level waste vaults	Solid LLW	27,000	2 vaults operational, additional 5 planned
Low activity waste vaults	Solid LLW, compacted waste, contaminated equipment, filters, sediment, job control waste, process beds, soils, resins, and lithium-aluminum melted forms	61,500	1 vault constructed additional 12 planned.
LLW disposal facility, slit trenches	Solid LLW	407,000	58 trenches planned
Z-area saltstone vaults	Solid LLW	1,110,000	2 vaults operational, additional 12 vaults planned

[a] Schedules and capacities for the facilities under design or construction are subject to changes such as availability of funds and permit issuance.

[b] Includes current capacity and projections through 2024.

Source: SR DOE 1994b; SR DOE 1995c; WSRC 1995a; WSRC 1995b.

taminated is managed as suspect soil. Solid LLW typically consists of protective clothing, contaminated equipment, irradiated hardware, spent lithium-aluminum targets (from tritium extraction), and spent deionizer resins. All LLW is disposed of in the Solid Waste Disposal Facility in E-Area between F- and H-Areas. Wastes are compacted and packaged for burial. Monitoring wells are located near each disposed waste area to verify performance and to monitor groundwater in the vicinity of the vaults. As of December 1994, the total inventory of LLW disposed of at SRS was 676,400 m^3(884,700 yd^3) (DOE 1995gg).

Mixed Low-Level Waste. Management of mixed wastes includes safe storage until treatment is available. Mixed LLW is stored in 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, Savannah River Technology Center mixed waste storage tanks, and the organic waste storage tanks. 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.

The Hazardous/Mixed Waste Treatment and Disposal Facility and the Consolidated Incineration Facility will process both mixed and hazardous wastes. The mixed waste management plan for SRS, illustrated in figure H.2.2–4, has been reevaluated through the development of a Site Treatment Plan in accordance with the *Federal Facility Compliance Act* of 1992. Mixed waste inventories are listed in table H.2.2–10. Treatment facilities and processes are listed in table H.2.2–7. The capacities and status of the different storage facilities are listed in table H.2.2–8.

Hazardous Waste. Typical hazardous wastes at SRS include lead, mercury, cadmium, 1,1,1-trichloroethane, leaded oil, trichlorotrifluoroethane, benzene, and paint solvents. Figure H.2.2–5 illustrates the processing of hazardous wastes at SRS. Table H.2.2–11 lists hazardous waste storage facilities at SRS. This waste is stored in RCRA-permitted buildings in B-, M-, and N-Areas, and open storage

TABLE H.2.2–10.—*Mixed Low-Level Waste at Savannah River Site*

Waste Matrix	Number of Waste Streams	Inventory as of September 30, 1994 (m^3)	Number of Waste Streams Five-Year Projection	Total Generation Five-Year Projection (m^3)
Aqueous liquids/slurries	6	158	8	4,692
Debris	12	4,069	13	3,840
Special waste	4	83	4	32
Homogeneous solids	12	2,726	5	155
Lab packs	1	8	1	5
Organic liquids	3	139	4	587
Soil/gravel	2	17	0	0
Total	40	7,200	35	9,311

Source: DOE 1995gg; WSRC 1995a; WSRC 1995b.

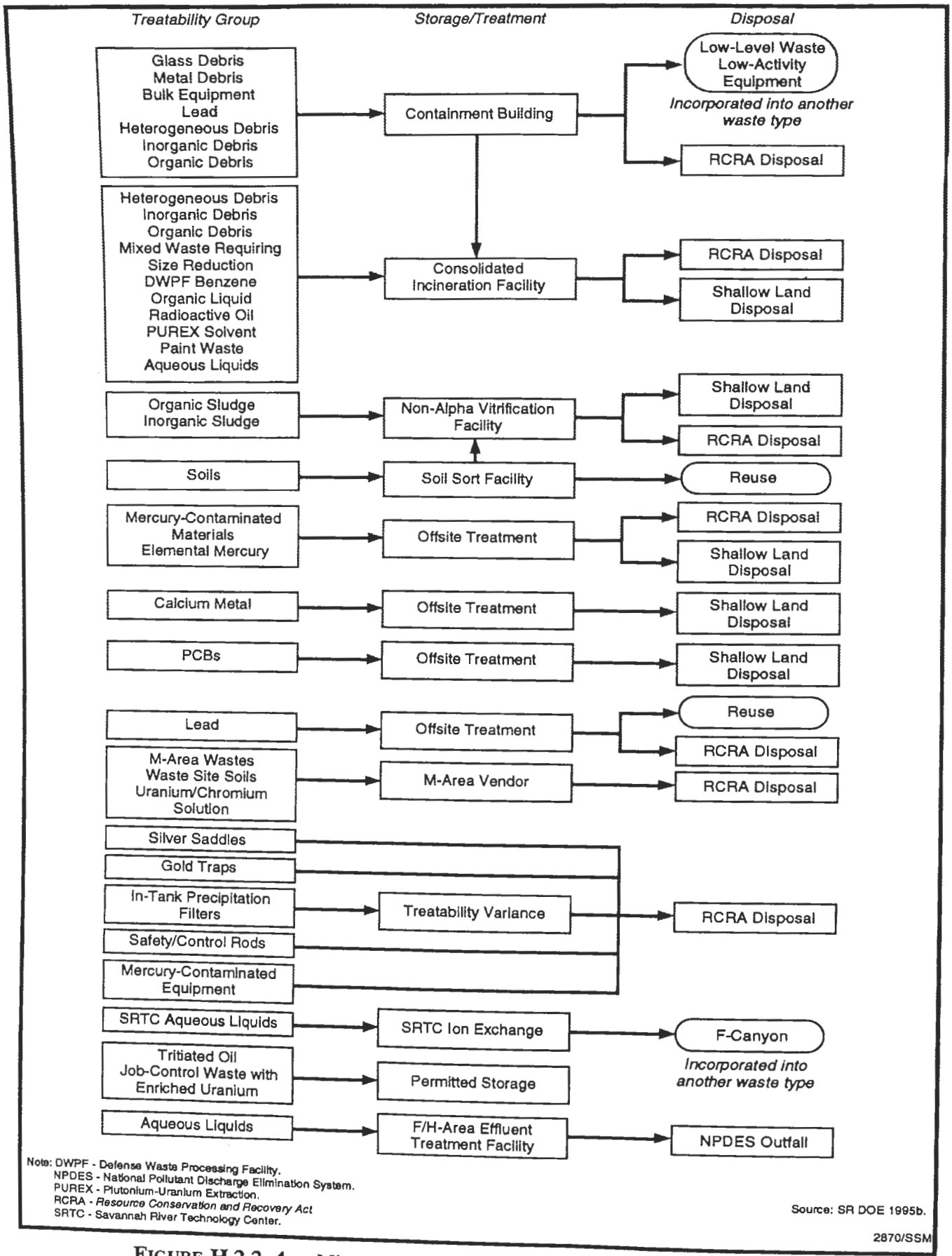


FIGURE H.2.2–4.—*Mixed Waste Management Plan at Savannah River Site.*

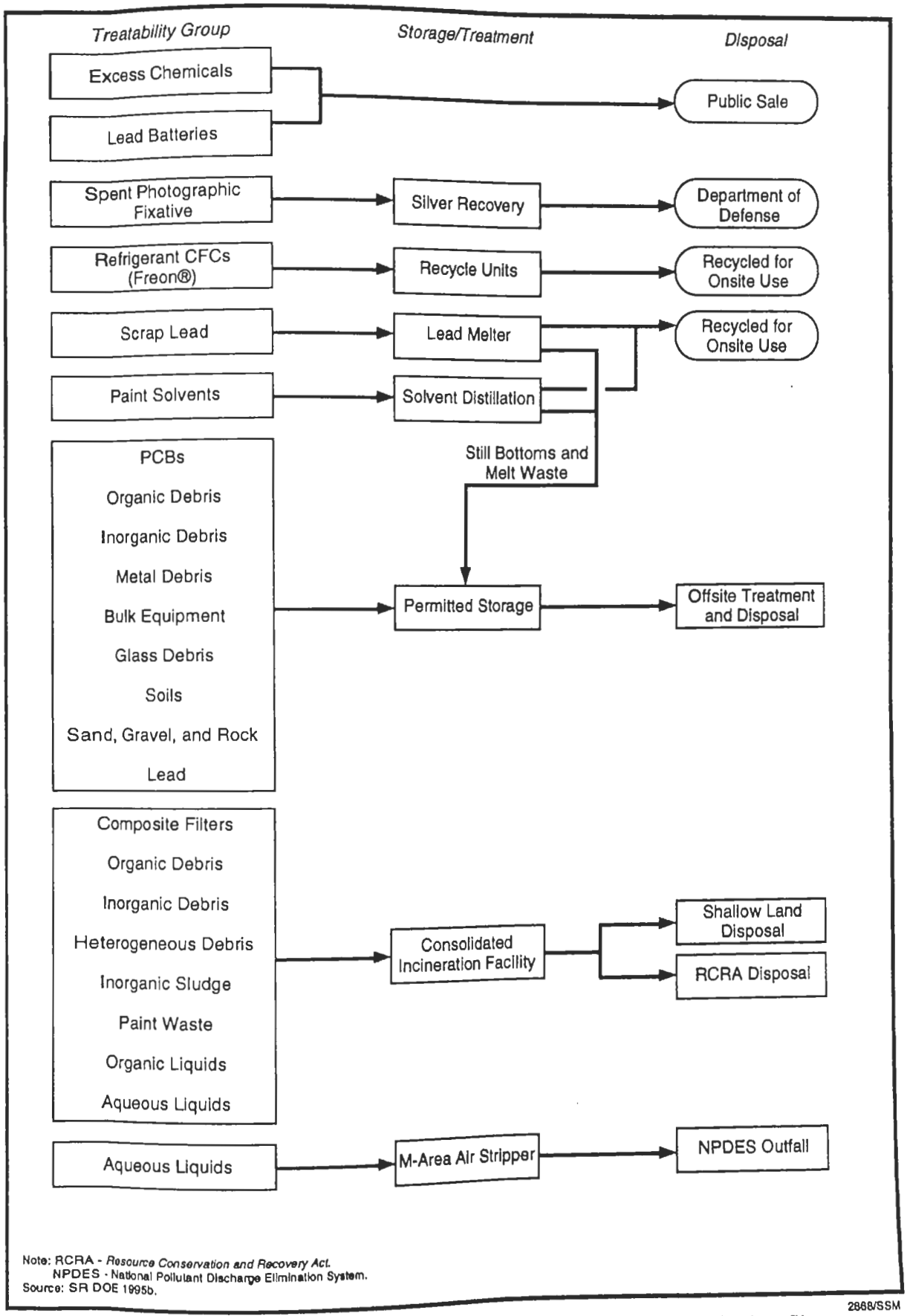


FIGURE H.2.2–5.—*Hazardous Waste Management Plan at Savannah River Site.*

TABLE H.2.2–11.—*Hazardous Waste Storage at Savannah River Site*

Storage Unit	Input Capability	Capacity (m^3)	Comment
Solid Waste Storage Pads	Containerized solid hazardous wastes only	1,758	
Building 316-M	Containerized hazardous wastes	117	RCRA-permitted interim status
Building 710-B	Containerized hazardous wastes	146	RCRA-permitted interim status
Building 645-N	Containerized hazardous wastes	171	RCRA-permitted interim status
Building 645-4N	Containerized hazardous wastes	426	RCRA-permitted interim status

Source: SR DOE 1995c.

areas located on the asphalt pads within the fenced area of N-Area. DOE started to send hazardous waste offsite for treatment and disposal, but in 1990 imposed a moratorium on shipments of hazardous materials from radiological areas. Waste that is not subject to the moratorium is shipped to an offsite vendor for processing and disposal. SRS annually publishes the SRS Tier Two Emergency and Hazardous Chemical Inventory Report, which lists hazardous chemicals that are present above their minimum threshold level or that are categorized as extremely hazardous substances by the emergency planning *Community Right-to-Know Act* of 1986. The annual reports filed under the *Superfund Amendments and Reauthorization Act* for the SRS facilities include year-to-year inventories of these chemicals.

Nonhazardous Waste. Municipal solid waste generated at SRS is currently being sent to a permitted offsite disposal facility. DOE is evaluating a proposal to participate in an interagency effort to establish a regional solid waste management center at SRS (DOE/EA-0989, DOE/EA-1079).

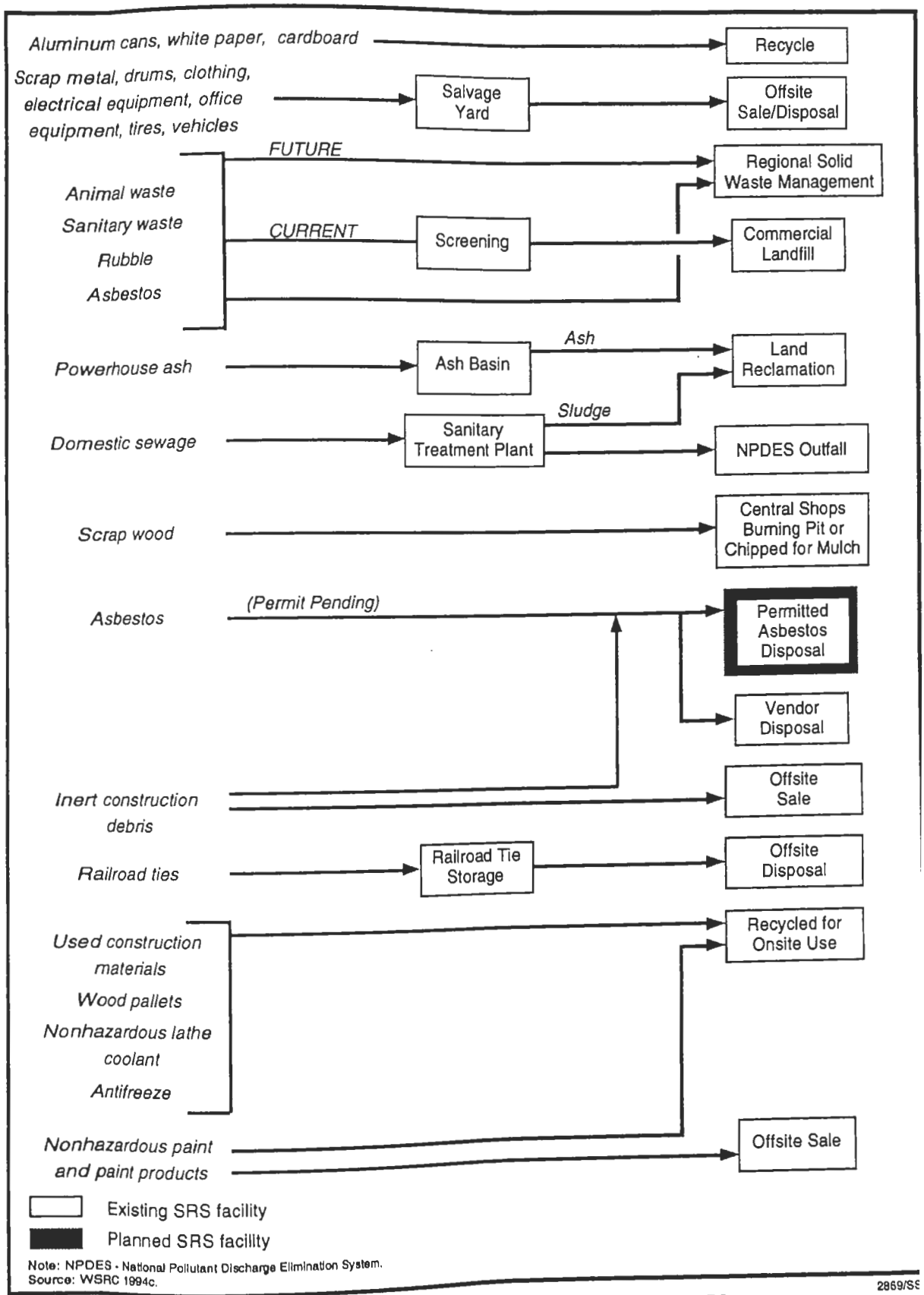
SRS disposes of other nonhazardous wastes in addition to the nonhazardous wastes disposed of in the sanitary landfill. These wastes consist of scrap metal, powerhouse ash, domestic sewage, scrap wood, construction debris, and used railroad ties.

Scrap metal is sold to salvage vendors for reclamation. Powerhouse ash and domestic sewage sludge are used for land reclamation. Scrap wood is burned onsite or chipped for mulch. Construction debris is used for erosion control. Railroad ties are shipped offsite for disposal. Nonhazardous waste management is illustrated in figure H.2.2–6.

H.2.3 Kansas City Plant

At Kansas City Plant (KCP), stockpile activities for national security result in the generation and management of hazardous, solid industrial, and sanitary wastes. No LLW or mixed LLW are routinely generated. However, operations resulting in the generation of LLW or mixed LLW may occasionally occur. There is no spent nuclear fuel, high-level, and TRU waste associated with the fabrication of nonnuclear components. The manufacturing operations include machining, plastic fabrication, plating, and electrical and mechanical assembly. Past activities associated with the manufacturing of nonnuclear components for nuclear weapons has resulted in some environmental contamination. The principal sources of contamination at KCP resulted from accidental spills and leaks during manufacturing operations. These spills and leaks have contaminated soils with Volatile Organic Carbons (VOCs), PCBs, and petroleum hydrocarbons. KCP is not on the NPL for sites requiring environmental restoration in accordance with CERCLA and SARA. However, there are some remedial actions required per a consent order between DOE and EPA. Pending future funding levels, these remedial actions are scheduled to be completed by 2001.

KCP does not presently dispose of waste onsite, although onsite disposal and leaks/discharges have occurred in the past. On March 6, 1989, EPA requested DOE to enter into a RCRA Section 3008(h) Administrative Order on Consent. On June 23, 1989, DOE and EPA Region VII signed the order. The provisions of the order require DOE to conduct all assessment and remediation activities regulated



Note: NPDES - National Pollutant Discharge Elimination System.
Source: WSRC 1994c.

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FIGURE H.2.2–6.—*Nonhazardous Waste Management Plan at Savannah River Site.*

under the order in accordance with approved environmental restoration remediation schedules.

Pollution Prevention. A formal Waste Minimization and Pollution Prevention Awareness Program has been initiated and is ongoing at KCP to comply with EPA regulations and DOE orders. This program includes coordinating the development, promotion, implementation, and reporting of site-wide waste reduction activities. Activities include establishing site-wide recycling and source reduction programs for all waste streams. Near-term objectives are to reduce the disposal volume of sanitary, hazardous, and LLW streams. KCP will pursue and adopt appropriate processes and programs to minimize and recycle KCP wastes.

Low-Level Waste. KCP typically generates very small quantities of LLW (<1 m^3/yr). Activities that generate LLW are the disassembly and testing of irradiated components, scheduled replacement of tritium exit signs, removal of used radioactive sources, and general debris (i.e., small amounts of contaminated cleanup towels, disposable gloves, and packing materials) from laboratory and assembly operations. Liquid LLW is solidified and mixed into concrete or plaster of paris for final handling and disposal in accordance with NTS waste acceptance criteria.

LLW is accumulated and stored in two controlled access areas used to store both LLW and mixed waste. LLW is stored onsite until sufficient quantities accumulate to warrant shipment to approved LLW disposal facilities at NTS. The last shipment of solid LLW took place in September 1995. The current inventory of LLW in storage is <1 m^3.

Mixed Low-Level Waste. KCP currently has no mixed waste in storage. Process changes have been made to control the generation of mixed waste. The potential exists for mixed waste to be generated by changes in conditions in current operations or by new processes being brought into KCP through nonnuclear consolidation or new business. KCP mixed waste would be stored with LLW in a controlled access, RCRA-permitted storage area.

Hazardous Waste. Hazardous waste is generated by a number of activities at KCP and consists of wastes such as acidic and alkaline liquids, solvent, and oils and coolants. Processes such as plating, etching, electronic assembly, metals and plastics machining and forming, and wastewater treatment are the principal generating processes. Waste stream residue generated at KCP that is not reclaimed, treated onsite at the Industrial Wastewater Pretreatment Facility, or recycled, is manifested and shipped under contract with waste transporters to permitted offsite facilities. KCP utilizes processes that do not require a permit under RCRA in order to treat hazardous wastes.

Hazardous wastes are managed in compliance with RCRA requirements as delineated in the Operating Permit issued by the Missouri Department of Natural Resources under the provisions of 40 CFR 270-272. KCP currently operates RCRA interim status waste storage areas for containerized nonradioactive hazardous wastes and bulk storage tanks for nonradioactive hazardous wastes.

The KCP Environmental Restoration Program serves to identify the nature and extent of environmental contamination at inactive waste sites. The site investigations conducted to date have indicated that hazardous waste constituents found in soil and groundwater at KCP are associated with past operations and are found at or near units now considered regulated hazardous waste management and solid waste management units. Site reevaluation visits are conducted by KCP personnel for all treatment, storage, or disposal facilities utilized by KCP.

Waste that requires disposal under TSCA continues to decrease. The primary generation source of PCB wastes over the past 15 years has been equipment upgrades and electrical substation replacement (i.e., replacement of transformers). These projects are now complete, and this category of waste is primarily generated from restoration and remediation projects.

Hazardous waste quantities generated at and subsequently shipped offsite from KCP in 1994 are shown in table H.2.3–1. A summary of the hazardous waste storage facilities is shown in table H.2.3–2.

Nonhazardous Waste. Nonhazardous wastes are generated routinely and include general plant refuse such as paper, cardboard, glass, wood, plastics, scrap, metal containers, etc. Nonhazardous wastes are segregated and recycled, whenever possible. The wastes are transported to a sanitary landfill. Sanitary wastewaters are discharged to the sanitary sewer in compliance with Kansas City, MO, sewer-use ordinance provisions and permit discharge limits. Biomedical

TABLE H.2.3–1.—*Hazardous Waste Quantities Shipped Offsite in 1994, Kansas City Plant*

Description	Number of Shipments Containing Description	Quantity (kg)	Estimated Volume (m^3)[a]
Aerosols	1	2,480	2.5
Combustible liquid, n.o.s.	5	32,660	32.7
Corrosive liquid, n.o.s.	1	1,720	1.7
Cyanides, inorganic, n.o.s.	1	51	< 0.1
Environmentally hazardous substances, solid, n.o.s.	21	110,297	73.5
Flammable liquids, n.o.s.	4	20,930	20.9
Flammable liquids, poisonous, n.o.s.	1	1,180	1.2
Hazardous waste, liquid, n.o.s.	3	25,100	25.1
Hazardous waste, solid, n.o.s.	33	261,250	174.2
Isocyanate solutions, n.o.s.	1	3,830	3.8
Mercury	1	154	0.1
Polychlorinated biphenyls	3	10,555	7.0
Polychlorinated biphenyls (less than one pound reportable quantity)	5	41,485	27.7

[a] For those shipments in which only a mass quantity was provided, a volume estimate was made based on density factors of 1,000 kg/m^3 for liquids and 1,500 kg/m^3 for solid.
Note: n.o.s. - not otherwise specified.
Source: DOE 1995h.

TABLE H.2.3–2.—*Hazardous Waste Storage Capability at Kansas City Plant*

Storage Unit	Input Capability	Design Capacity[a] (m^3)	Comment
2x40 yd^3 waste dumpsters	Solid hazardous waste (construction/D&D asbestos debris)	61.2	Operational; interim status
Acid pad	Liquid and solid hazardous waste (also sludge)	180.0	Operational; interim status
Acid plating waste tank	Liquid hazardous waste (also sludge)	22.7	Operational; interim status
Alkaline plating waste tank	Liquid hazardous waste (also sludge)	22.7	Operational; interim status
Bulk solvent waste tanks	Liquid hazardous waste	60.6	Operational; interim status
Demolition lot	Liquid and solid hazardous waste (also sludge, gas)	668.0	Operational; interim status
L-lot	Liquid hazardous waste	758.0	Operational; interim status
Oil/coolant storage tank	Liquid hazardous waste (also sludge)	30.3	Operational; interim status
PCB waste tank	Liquid hazardous waste (also sludge)	30.3	Operational; interim status
Reclamation area	Liquid and solid hazardous waste (also sludge)	16.0	Operational; interim status
Red-X lot	Liquid and solid hazardous waste (also sludge, gas)	250.0	Operational; interim status
Test cell #1	Solid hazardous waste (cyanide wastes)	82.5	Operational; interim status
Test cell #2	Liquid and solid hazardous waste (also gas)	82.5	Operational; interim status
Test cell #3	Solid hazardous waste (classified wastes)	82.5	Operational; interim status
Test cell #4	Liquid hazardous waste (PCB liquids)	82.5	Operational; interim status
Test cell #11	Liquid and solid hazardous waste (also sludge)	22.5	Operational; interim status

[a] Schedules and capacities for facilities under design or construction are subject to changes based on the availability of funds, permit issuance, etc.

Source: DOE 1994n; KCP 1995a:4.

waste is incinerated offsite at an incinerator permitted and approved by the Kansas Department of Health and Environment.

KCP also generates wastes that do not meet the definition of hazardous wastes and are not allowed to be incorporated with normal refuse sent to municipal solid waste landfills. These wastes are managed on a case-by-case basis in accordance with applicable regulations or best management practices.

H.2.4 Pantex Plant

This section describes the baseline conditions and specific waste management operations at Pantex. As part of its normal operation, Pantex generates low-level, mixed low-level, hazardous, and nonhazardous wastes. Tables H.2.4–1 and H.2.4–2 present a detailed description of treatment and storage facilities and their estimated capacities.

Pantex's goals regarding the management of LLW, mixed LLW, and hazardous wastes are as follows:

- Minimize the volumes of low-level radioactive and hazardous wastes generated to the extent technologically and economically practicable
- Recycle those wastes using the best available technology
- Minimize contamination of existing or proposed real property and facilities
- Ensure safe and efficient long-term management of all wastes

Pollution Prevention. The Pantex Waste Minimization Program was formed to define an effective waste minimization system for the site. A committee provides awareness of the program, identifies tasks, and provides a liaison between the site and outside entities. Some of this program's accomplishments are listed below:

- Compact 1,200 drums to approximately 250 drums using a compactor
- Separate radioactive and hazardous waste materials when shearing weapons components
- Reclaim oil, antifreeze, and refrigerant
- Substitute a scintillation solution that is nonhazardous
- Reuse explosives and solvents
- Repackage paint into smaller containers
- Substitute naphtha with nonhazardous biodegradable cleaning solutions

Transuranic Waste. No TRU waste or mixed TRU waste is currently generated at Pantex during normal operation. However, there is potential for an off-normal event to generate small amounts of contact-handled TRU waste or mixed TRU waste during a weapon dismantlement activity. Three drums of TRU waste were generated several years ago from an incident during weapon dismantlement. Ultimately, Pantex plans to ship its TRU waste to a DOE-approved storage site when one is available. In the interim, approximately 1 m^3 of TRU waste is temporarily stored in Building 12-42 (DOE 1995gg).

Low-Level Waste. The waste streams for LLW have the following options available for management consideration:

- Continue to ship to an approved DOE disposal site such as NTS
- Compact solid waste, if possible
- Improve computerized tracking of radioactive waste
- Implement an improved segregation program

Solid LLW consists of contaminated parts from weapons A/D functions and waste materials associated with these functions, such as protective clothing, cleaning materials, filters, and other similar materials. The compactible portions of this waste are processed at the Pantex Solid Waste Compaction Facility and staged along with the noncompactible portions for shipment to a DOE-approved disposal site. Table H.2.4–3 lists Pantex's primary LLW streams, how they are generated, primary radioactive constituents, and method of storage or disposal.

TABLE H.2.4–1.—*Waste Treatment Capability at Pantex Plant*

Treatment Unit	Treatment Method(s)	Input Capability	Output Capability	Total Capacity[a] (m^3/yr)	Comment
Batch Master Hazardous Waste Tank System (Bldg. 12-68)	Filtration, neutralization, and precipitation	Bldg. 12-5C metal cleaning bath, plating process waste, sodium hydroxide radiator cleaner, and spent electrolyte solutions	Metal precipitates to Hazardous Waste Storage Pad and effluent to wastewater treatment plant	Process as needed	Nonoperational due to pending closure
Building 11-15A	Immobilization	Mixed LLW	To be determined	185	Planned
Building 11-9	Immobilization	Mixed LLW	To be determined	185	Planned
Building 11-9S	Stabilization and macroencapsulation	Mixed LLW and hazardous waste	Sent to hazardous waste treatment and processing facility when completed	2 m^3/treatment	Also used as 90-day accumulation area for hazardous and mixed LLW
Building 11-50 (Wastewater Treatment Facility)	Filtration of organics and undissolved HE particles	HE machining operations	Playa 2	684	
Building 12-43 (HE Filtration Facility)	Filtration of HE and carbon	Explosive machining operations in Building 12-24	Playa 1	180	Sock filter and carbon filter
Building 12-73	Settlement and filtration	HE-contaminated water	Sanitary sewage system	Variable	Settling tank and fabric filter system
Burning Ground: one cage, one tray, and one pan	Open burning or detonation	Solid mixed LLW and hazardous waste	Ash to 11-71X storage pad	909	Design capacity. Interim permit until April 2001.
Closed-loop decon system	Reduction	Contaminated lead (solid mixed LLW)	Acid bath (liquid mixed LLW) to offsite commercial vendor	Campaign	One process per year. Standby mode.
Compactor (Bldg. 12-42)	Hydraulic ram compactor-in-drum compaction	Solid LLW (gloves, kim wipes, paper)	Compacted LLW in 17H 55-gallon drums to storage igloo 4-56	Process as needed	No TRU waste, waste greater than Class C, mixed waste, free liquids, or gases
Hazardous Waste Treatment & Processing Facility	Immobilization repackaging, neutralization compaction, shredding, sorting, and solidification	Liquid and solid LLW, mixed LLW and hazardous waste	To be determined. May be stabilized solids	500	Available for treating mixed waste by 1998
Sanitary Sewage Treatment System	Aeration and anaerobic microbial action	Sanitary sewage and industrial waste	Lagoon (chlorine pretreatment)	2,460,000 L/day	Permitted flow. Operational flow about 1,310,000 L/day.

[a] For those facilities already in use this is a normal operating capacity; whereas, for facilities under design or construction this is a design capacity. Schedules and capacities for facilities under design or construction are subject to changes such as availability funds and permit issuance.

Source: DOE 1993h; DOE 1994n; DOE 1995gg; PX DOE 1995i; PX DOE 1996b.

TABLE H.2.4–2.—*Waste Storage Capability at Pantex Plant*

Storage Unit	Input Capability	Total Capacity (m^3)[a]	Comment
Buildings 4-46, 4-72 and 4-74	Liquid and solid mixed LLW	187	Permitted capacity pending permit modification. Operating capacity is 120 m^3.
Buildings 11-7A and 11-7B	Liquid and solid mixed LLW	402	Permitted and operating storage capacity.
Building 11-7N Pad	Various liquid/solid hazardous waste, mixed LLW, and LLW	125	Interim permit dated April 19, 1990. Permitted and operating capacity.
Building 11-9N Pad	Various liquid and solid hazardous wastes	379	Permit dated March 1994. Permitted capacity. Operating capacity is 252 m^3.
Conex containers WM-1 to WM-8	Containerized solid mixed low-level and silver photo wastes	575	Permit dated April 1, 1991. Permitted capacity. Operating capacity is 120 m^3.
Conex containers WM-1A, WM-1B, WM-3A, WM-5A, WM-5B	Containerized liquid and solid LLW	377	No plans to receive offsite waste. Permitted capacity pending permit modification. Operating capacity is 75 m^3.
Conex containers (25)	Solid/liquid LLW	1,800	Each Conex can store 72 55-gal drums (15 m^3) for an operating capacity of 375 m^3.
Magazine 4-50	Liquid/solid mixed LLW, hazardous waste, and LLW	421	Final permit dated April 24, 1992. Permitted capacity. Operating capacity is 40 m^3.
Magazine 4-56	Liquid and solid LLW	421	Temporary storage before shipment to NTS. Operating capacity is 40 m^3.
RCRA Hazardous Staging Facility (Bldg. 16-16)	Containerized liquid/solid LLW and mixed LLW	1,050	Permitted capacity. Operating capacity is 333 m^3. Currently under construction.

[a] Schedules and capacities for facilities under design or construction are subject to changes such as availability of funds and permit issuance.

Source: DOE 1994n; PX DOE 1995i; PX DOE 1996b.

Table H.2.4–4 presents the inventory of LLW at Pantex as of December 2, 1994. A 5-year projection is also given.

Mixed Low-Level Waste. The waste streams for mixed LLW have the following options available for management consideration:

- Treat to satisfy Land Disposal Restriction requirements and store onsite. This is the option now being used at Pantex (PX DOE 1996b:4-193).
- Treat to satisfy Land Disposal Restriction requirements and ship to an approved commercial facility for storage or disposal.
- Ship offsite for treatment and disposal.

Pantex generates solid mixed LLW during weapons component testing. These wastes consist primarily of depleted uranium and beryllium residue and fragments from explosives components tests, contaminated gravel, cleaning materials, and protective clothing associated with these operations. Other mixed LLW streams include cleaning materials from weapons A/D operations. Table H.2.4–5 lists Pantex's primary mixed waste streams, composition, method of process, and treatment alternatives. Pantex will manage mixed waste in accordance with the Pantex Plant *Federal Facility Compliance Act Compliance Plan.* Pantex currently has a contract with a commercial facility for mixed waste treatment and/or disposal. Table H.2.4–6 lists organic liquid mixed LLW waste streams that are being evaluated for commercial treatment and/or disposal. Table H.2.4–7 lists the mixed waste storage inventory as of September 1995. Projections for the following 5 years are also included.

Mixed LLW (HE contaminates only) is currently treated at the Burning Ground which has a permitted capacity of 180 m^3/yr (236 yd^3/yr) (DOE 1995gg). The Hazardous Waste Treatment and Processing Facility is being planned to house mixed waste mobile treatment units.

Hazardous Waste. The waste streams for hazardous waste have the following options available for management consideration:

- Continue to ship to approved hazardous waste disposal facilities
- Encapsulate solid waste and ship to an approved DOE disposal site
- Treat onsite to neutralize corrosive wastes

Table H.2.4–8 presents the inventory and 5-year projection for hazardous waste at Pantex as of December 2, 1994. Two facilities treat hazardous waste: the Burning Ground Facility and the Hazardous Waste Treatment Processing Facility. The Burning Ground is an open-burning area where explosives, explosives-contaminated waste, and explosives-contaminated spent solvents are burned, resulting in a large reduction in volume. The Hazardous Waste Treatment and Processing Facility will house liquid-phase and solid-phase hazardous, low-level, and mixed waste processing facilities. The facility has been planned and approved and should be available in 1998 (DOE 1995gg).

Not all of the hazardous waste is treated at Pantex. Table H.2.4–9 shows the amount of hazardous waste shipped offsite in 1994. There are several separate storage facilities for hazardous wastes. At the Hazardous Waste Drum Storage Area, all drums containing liquid are placed in spill-containment pans. The facility is inspected weekly for leaking drums. Small lab samples of hazardous waste are stored in two chemical storage containers in this area. The materials stored there include asbestos, mercury-contaminated wastes, Burning Ground ash, and electroplating sludge. At Building 16-1, used crank case oil is stored underground until sufficient quantities are generated for offsite processing.

Class 1 non-RCRA hazardous waste includes waters that contain asbestos, PCBs with a concentration greater than 50 parts per million (ppm), and oils with a total petroleum hydrocarbon concentration greater than 1,500 ppm. Table H.2.4–10 presents the Class 1 non-RCRA hazardous waste streams, current inventories as of December 2, 1994, and projected generation volumes. Medical waste is defined as any solid waste that is generated in the diagnosing, treating, or immunizing of human beings or animals, in research, or in producing or testing biologicals. This waste includes cultures and stocks, pathological wastes,

TABLE H.2.4–3.—*Low-Level Waste Streams at Pantex Plant*

Sources	Waste Description	Radioactive Constituents	Primary Materials	Disposition
Assembly/ dismantlement operations	Debris from demilitarization and sanitization operations	Thorium, U–238, tritium	Generally noncompactible crushed/granulated plastic and metal debris	Disposed of at DOE-approved offsite facility
Assembly/ dismantlement/ stockpile surveillance	Compactible material from normal assembly/dismantlement/stockpile surveillance	U–238, tritium, thorium, and plutonium	Lab wipes and other support materials	Disposed of at DOE-approved offsite facility
Assembly/ dismantlement and stockpile surveillance operations	Radiological materials from normal operations associated with weapons assembly, dismantlement, facility surveillance, container monitoring and routine sample counting operations	U–238, tritium, thorium, and plutonium	Protective clothing, wipes, swipes, tape, plastic and other material in the radiation protection program	Disposed of at DOE-approved offsite facility
Weapon component testing and evaluation	Debris generated during past testing of mock devices associated with any known waste stream	Depleted U–238 residue	Contaminated soil and gravel, additional miscellaneous materials	Stored onsite pending eventual shipment to DOE-approved disposal site
Decontamination products	Materials generated during the decontamination of a concrete assembly work cell (one time generation)	Tritium	Protective clothing, concrete rubble, solidified liquids, tools, equipment, plastic and paper products containing tritium	Stored onsite pending eventual shipment to DOE-approved disposal site

Source: PX DOE 1995i.

TABLE H.2.4–4.—*Low-Level Waste Inventory at Pantex Plant*

Waste Stream Name	Inventory as of December 2, 1994 (m^3)	Total Generation Five-Year Projection (m^3)
Beryllium waste, radioactive	114	0[a]
Tritium contaminated waste (solid/liquid)	55	179
Lab packs, nonregulated radioactive (solid)	1	1
Contaminated soil	8	0
Waste water	7	9
Contaminated metal, radioactive	2	0.02
Desiccant, radioactive	0.2	22
Plant refuse (paper, foam, rags, cardboard)	105	711
Miscellaneous ash, radioactive	9	0
Total	301	922

[a] One-time event, no further generation is expected.

Source: PX DOE 1995i.

TABLE H.2.4–5.—*Mixed Low-Level Waste Streams at Pantex Plant* [Page 1 of 2]

Treatability Group	Waste Stream Name	Composition[a]	Process Description	Treatment Alternatives
Organic liquids	Paint waste - organic liquids	Paint and solvent	Stripping, surface preparation, and repainting	Planning packed bed reactor (Mobile Treatment Unit)
	Spent solvents	Freon, methyl ethyl ketone, High Explosive (HE), and dimethyl sulfoxide	Cleaning dissolution of HE	Planning hydrothermal oxidation (Mobile Treatment Unit or offsite commercial vendor)
	Contaminated liquid	Mercury-contaminated oil	Vacuum pump oil change	Planning packed bed reactor (Mobile Treatment Unit)
Aqueous liquids	Wastewater	Water, HE, chromium, lead	Water-let and thermal shock activities	Planning evaporation oxidation and stabilization (Mobile Treatment Unit)
	Alodine solution	Chromic acid, fluoride salt and iron cyanide	Surface preparation before paint removal	Planning plating waste treatment (Mobile Treatment Unit)
	Metal cleaning waste	Water, alodine, nitric acid, U, Th, cadmium, Cr, Lead, and Hg	Etching and cleaning of metals	Planning plating waste treatment (Mobile Treatment Unit)
Homogeneous solids	Wastewater sludge from explosives	Explosive-contaminated solids, dimethyl sulfoxide	Filtering of wastewater with HE	Open-air burning
	Burning Ground ash	Inorganic ash residue, metals, and some unburned organic material	Burning of HE and HE-contaminated materials	Planning stabilization/barium sulfate (Mobile Treatment Unit)
	Process residues	Residues resulting from treatment of mixed waste	Waste not generated until onsite mixed waste treatment commences in 2000.	Planning stabilization (Mobile Treatment Unit)
Soils/gravels	ER potential mixed waste (soils)	Contaminated soils from solid waste management units, spill cleanup, drill cuttings, sample wastes, etc.	ER program site contaminated soils	Planning thermal desorption and stabilization
Debris waste	Solvent-contaminated solid material	Alcohol, kimwipes, filters, rags, leads, solvents	Weapon dismantlement and maintenance	Planning macroencapsulation
	Contaminated scrap metal	Contaminated scrap metal from demilitarized and sanitized weapons parts	Demilitarized and sanitation activities	Planning macroencapsulation
	Lead-contaminated waste, solid	Seals and tape intermixed with gloves and paper	Demilitarization and sanitization activities	Planning macroencapsulation

TABLE H.2.4–5.—*Mixed Low-Level Waste Streams at Pantex Plant* [Page 2 of 2]

Treatability Group	Waste Stream Name	Composition[a]	Process Description	Treatment Alternatives
Debris waste (Continued)				
	Mercury-contaminated solids	Glass bulbs, mercury-contaminated solids	Maintenance of lighting	Planning macroencapsulation
	Heterogeneous debris-metal contaminated waste	Metals, alodine, light ballasts, beryllium	Maintenance and special activities	Planning macroencapsulation
	Heterogeneous debris	Solid wipes, gloves, and anti-C suits	Painting, paint removal, maintenance testing, and disarmament activities	Planning macroencapsulation
	Plutonium-contaminated solids	Personnel protective equipment, epoxy, floor sweepings, paint, and paint thinner	Dismantlement operations in Building 12-98	Planning macroencapsulation
	Contaminated explosives and contaminated support materials	Support materials with explosive residue, mercury, and solvents	Assembly/disassembly process	Planning macroencapsulation
Lab packs	Lab packs	Epoxy, uranium, acid, lead, thorium nitrate crystals	Disposal of chemicals from testing labs	Proposed radiation surveying followed by separation and onsite treatment if unable to reclassify as hazardous
	Miscellaneous organic liquids	Halogenated and nonhalogenated solvents	Paints, solvents, and special product materials storage	Planning hydrothermal oxidation (Mobile Treatment Unit)
	Scintillation fluids	Scintillation fluids packaged with vermiculite	Radioactivity testing	Commercial treatment. Fluids need to be bulked first.
Special wastes	Used batteries	Nickel, cadmium, lead, silver, mercury, and asbestos	Dismantlement activities	Decontaminate and recategorize as hazardous waste
	Lead waste	Portion of lead drum liners	Removal of lead liners	Planning treatment utilizing decontamination. If not successful, then macroencapsulation (Mobile Treatment Unit)
	Aerosol containers	Discarded spray paint cans	General maintenance	Decontamination

[a] Typical radionuclides that may be present in the mixed waste include uranium, thorium, and tritium.

Note: ER - environmental restoration.

Source: DOE 1994k; DOE 1995gg.

TABLE H.2.4–6.—*Organic Liquid Waste Stream Candidates for Commercial Treatment and/or Disposal*

Waste Stream	Quantities of Waste (L)	Treatable Volume (L)	Composition[a]	Process Description
Lab packs[b]	4,030	988	Scintillation vials packed in cardboard boxes in vermiculite	Laboratory waste packages
Organic debris; solvent-contaminated	163	163	Joint test assembly cleanup water, oil, water	Support material
Spent solvent	3,920	1,740	Scintillation vials packed in cardboard boxes in vermiculite; joint test assembly cleanup water; freon with HE	Spent solvents
Mercury-contaminated liquids	492	492	Oil contaminated with mercury	Discarded oil from vacuum pumps in laboratory equipment; source of mercury contamination from samples analyzed in lab equipment
Total	8,605	3,383		

[a] Mixed LLW stream may include uranium, thorium, tritium, and plutonium.
[b] Cardboard boxes and vermiculite used to pack scintillation vials will be recontainerized and treated as separate sampling lots.
Source: PX DOE 1995i.

TABLE H.2.4–7.—*Mixed Low-Level Waste Inventory at Pantex Plant*

Treatability Group	Number of Waste Streams	Inventory as of March 1995 (m^3)	Total Generation Five-Year Projection (m^3)
Aqueous liquids/slurries	3	2	22
Organic liquids	3	3	2
Homogeneous solids	3	19	29
Soils	1	None	190
Debris waste	8	97	714
Lab packs	3	7	4
Special wastes	3	<1	1
Total	24	128	963

Source: DOE 1995gg.

human blood and blood products, sharps, animal waste, and isolation wastes. Pantex currently generates approximately two boxes of medical waste per week, each with a capacity of 0.142 m^3 (0.186 yd^3). The annual generation rate of medical waste at Pantex is approximately 15 m^3 (19 yd^3) (PX DOE 1995i:14-15). Medical waste is dispositioned through a commercial vendor who picks up and transports the medical facility's biomedical and infectious waste.

Nonhazardous Waste. The Sewage Treatment Quality Upgrade is a project for 1996 at Pantex. This project would upgrade Pantex's sanitary system to ensure that wastewater standards are met through secondary/tertiary treatment. This project includes upgrading the existing treatment lagoon to treat sewage, repairing and replacing existing deteriorated sewer lines, constructing a closed system to eliminate the use of open ditches for conveyance of industrial wastewater discharges, and implementing a plant stormwater management system.

TABLE H.2.4–8.—*Hazardous Waste Inventory at Pantex Plant*

Waste Stream Name	Inventory as of December 2, 1994 (m^3)	Total Generation Five-Year Projection (m^3)
Explosive-contaminated solid waste	4	23
Burning Ground waste from thermal treatment	1	7
Lab packs (solid)	0.4	6
Photographic film	0	0.7
Lead waste	0.7	0.08
Spent halogenated and nonhalogenated solvents and mixtures	2	34
Heavy metal contaminated parts	0	0.8
Contaminated soil[a]	0	14,800
Sodium hydroxide waste (solid)	0	8
Paint sludge	2	3
Wastewater from operations and monitoring[a]	0.4	34
Metal cleaner and photographic waste	0.05	13
Recyclable and nonrecyclable used batteries	0.4	197
Solvent-contaminated solids	3	29
Mercury (solid/liquid)	0	0.01
Sandblasting waste	0.6	1
Lead-contaminated waste	0	0.7
Miscellaneous organics (solid/liquid)	0.4	15
Contaminated engine oil	0.1	2
Oil filter waste	0.02	0.5
Miscellaneous discards contaminated with heavy metals	23	356
Empty organic compressed gas cylinders	0.3	24
Recyclable scrap metal with precious metals	0.2	1
Total	39	15,556[b]

[a] These waste streams are primarily associated with environmental restoration activities.

[b] Of this total, about 550 m^3 is directly from weapons activities.

Source: PX DOE 1995i.

TABLE H.2.4–9.—*Hazardous Waste Quantities Shipped Offsite in 1994, Pantex Plant*

Description	Number of Shipments Containing Description	Quantity (kg)	Estimated Volume[a] (m^3)
Hazardous waste, solid, n.o.s.	9	14,200	9
Corrosive liquids, n.o.s.	2	538	0.5
Flammable liquids, n.o.s.	1	202	0.2
Hazardous waste, liquid, n.o.s.	2	149	0.2
Oxidizing substances, solid, corrosive, n.o.s.	1	166	0.1
Oxidizing substances, solid, poisonous, n.o.s.	1	6	<0.1
Poisonous liquids, n.o.s.	1	28	<0.1

[a] For those shipments in which only a mass quantity was provided, a volume estimate was made based on density factors of 1,000 kg/m^3 for liquids and 1,500 kg/m^3 for solids.

Note: n.o.s. - not otherwise specified.

Source: DOE 1995h.

TABLE H.2.4–10.—*Class 1 Non-Resource Conservation and Recovery Act Hazardous Waste Inventory at Pantex Plant*

Waste Stream	Inventory as of December, 1994 (m^3)	Total Generation Five-Year Projection (m^3)
Beryllium waste	0	740
Empty containers	142	985
PCB-contaminated solids	0.05	0.05
Crank case oil	1	260
Asbestos solids	13	24
PCB-contaminated oil	0	0.06
Paint residue	3	53
Contaminated soil[a]	5	2,350
Metal cleaning waste (solid)	0	0.3
Wastewater[a]	24	1,600
Recyclable and nonrecyclable photographic waste	0.02	0.3
Contaminated metal	0.1	0.7
Antifreeze and engine coolants	0.3	337
Desiccant	0	4
Plant refuse, such as paper, foam, rags, and cardboard	51	543
Used oil filters generated during maintenance	3	23
Miscellaneous ash	4	5
Resins, tar, or tarry sludge (excess material from laboratories)	3	36
Total	249	6,961

[a] These waste streams are primarily associated with environmental restoration activities.

Source: PX DOE 1995i.

TABLE H.2.4-11.—*Class 2 Nonhazardous Waste Disposal in Amarillo Landfill from Pantex Plant*

Year	Total Disposal (kg)	Total Volume of Disposal (m^3)
1989[a]	79,600	53
1990	335,000	223
1991	307,000	205
1992	371,000	247
1993[b]	428,000	285
1994	589,000	393
1995-1999 (estimate)[c]	2,610,000	1,740

[a] Contract for disposal began in 1989 and included approximately 3 months.
[b] In midyear, recycling was stopped because of low cost effectiveness.
[c] Waste minimization efforts are expected to provide an average reduction of 4 percent each year.
Source: PX DOE 1995i.

lass 2 nonhazardous waste (general refuse) is ollected at each building from trash cans and placed dumpsters. This includes cardboard, computer per, white paper, colored paper, mixed steel, steel d aluminum cans, mixed metal, mixed plastic, am rubber, and glass. Currently, telephone directo-es, paper, certain plastics, and some steel and uminum cans are being recycled. The weights of lass 2 nonhazardous waste disposed of from 1989 1994 and the estimated volumes for 1995 through 999 are given in table H.2.4–11.

.2.5 Los Alamos National Laboratory

boratory research activities at LANL result in the neration of TRU, mixed TRU, mixed low-level, w-level, hazardous, and nonhazardous wastes. astes are treated, stored, and disposed of both on d offsite. LANL is not listed on the NPL. As a nction of obtaining a RCRA permit, however, the *zardous and Solid Waste Amendments* of 1984 ndate that permits for treatment, storage, and sposal facilities include provisions for corrective ion to mitigate releases from facilities in operation d to clean up contamination in areas designated as id waste management units at LANL. LANL does t generate or manage HLW. The site does manage mall amount of spent nuclear fuel originating from Omega West Reactor. This spent nuclear fuel is temporary storage at the Chemistry and Metal-gy Research Complex awaiting shipment to SRS long-term storage.

Pollution Prevention. Radioactive, hazardous, and mixed wastes are treated, stored, or disposed of at LANL. The total amount of waste generated and disposed of at LANL has been, and is being, reduced through the efforts of the pollution prevention and waste minimization programs at the site. The LANL Waste Minimization and Pollution Prevention Program is an ambitious program aimed at source reduction, product substitution, recycling, surplus chemical exchange, and waste treatment. The program is tailored to meet Executive Order 12780, DOE orders, and RCRA and EPA guidelines. All wastes at LANL, including radioactive, mixed, hazardous, and nonhazardous regulated waste, are included in the LANL Pollution Prevention Program. Reductions in the volumes of radioactive wastes generated have been achieved through methods such as intensive surveying, waste segregation, recycling, and use of administrative and engineering controls.

Transuranic Waste. The primary source of LANL liquid TRU waste is the processing of caustic and acidic wastes by the Plutonium Facility (Technical Area [TA]-55). Treatment of liquid TRU wastes yields a solid TRU waste and a liquid LLW that is further treated at TA-50. The pretreatment facility consists of storage and neutralization tanks, a clari-flocculator and filter tanks, two precipitate storage tanks, and an in-drum cement mixing area. Lime and/or iron sulfate are added to the liquid TRU stream, resulting in a precipitate containing over 99.9 percent of the plutonium and americium. The precipitate is mixed with cement in drums to form the solid TRU waste. Variations in waste volumes and radio-

active content result primarily from program changes, facility D&D activities, and general cleanup programs for laboratory areas.

The TRU waste size reduction facility at LANL is designed to repackage and reduce the volume of various types of metallic waste items such as glove boxes, process equipment, and ductwork. The items are processed in the disassembly/cutting area where attached combustible items are removed and where a plasma torch cuts it into smaller pieces for packaging. The pieces are placed into accepted WIPP containers, then sealed for storage at TA-54, Area G.

LANL has managed solid TRU waste at TA-54, Area G, since approximately 1957. Solid TRU and mixed TRU wastes are stored above ground on asphalt pads at TA-54, Area G. Membrane-covered fabric dome enclosures provide weather protection and prevention of run-on. Drums stored on pallets and fiberglass-reinforced, polyester-coated crates are fitted with skids to maintain them above the floor. Additional TRU container storage units are located within permanent structures at TA-3 and TA-55. These units support R&D activities and are not intended for long-term storage of mixed TRU waste. High-activity or remote-handled TRU wastes are placed in shafts at TA-54, Area G.

In January 1993, the New Mexico Environment Department issued Compliance Order 93-03, which required LANL to retrieve TRU wastes from aboveground earth-covered Pads 1, 2, and 4 and manage them in accordance with requirements of 40 CFR 264, Subpart I. Pursuant to the December 1993 Consent Agreement, LANL has initiated the TRU Waste Inspectable Storage Project to provide for retrieval and inspection of the wastes and replacement in new aboveground storage domes at TA-54, Area G.

In addition, LANL completed the Preconceptual Study for EPA in September 1994 to identify short- and long-term storage needs for mixed TRU waste. This study recommended constructing eight new storage domes for TRU waste at Area G by the year 2000. The domes will have the same structural design and operational capabilities as existing structures. However, based on estimates of anticipated TRU and mixed TRU waste generation, this design may not provide sufficient capacity for all wastes by the year 2000. New requirements for fire protection are being evaluated to determine whether they will further reduce available storage capacity by reducing aisle space.

Most of LANL's TRU waste is currently stored on four asphalt pads, all designated as RCRA interim status storage units. TRU wastes are currently being stored, pending the outcome of WIPP to serve as a repository for these wastes. Assuming WIPP is determined to be a suitable repository for these wastes, pursuant to the requirements of 40 CFR 191 and 40 CFR 268, these wastes will be treated to meet WIPP Waste Acceptance Criteria and packaged in accordance with DOE, NRC, and DOT requirements for transport to WIPP for disposal. The TRU Retrieval Tension Support Dome project will retrieve approximately 16,900 containers of TRU waste from three storage pads. Drums will be cleaned and inspected for corrosion and leakage. Extensively damaged drums and drums containing liquids will be overpacked. Drums which are not overpacked may have HEPA filters installed to prevent the potential for accumulation of hydrogen gas in the drum headspace during storage. All of the drums and crates will be reconfigured in six temporary storage domes erected exclusively for the storage of this waste.

Mixed TRU waste represents the majority of the mixed waste stored at LANL, accounting for approximately 80 percent of the total volume of TRU waste. All mixed TRU waste has been characterized by process knowledge. Some of the waste requires remote-handling during waste management. The regulatory status of stored mixed TRU waste can be broken down into three categories: (1) facilities that meet RCRA storage requirements; (2) facilities designed prior to and subject to RCRA but not in compliance with current storage requirements; and (3) facilities designed and operated prior to RCRA and subject to RCRA.

LANL has identified approximately 7,690 m^3 (10,000 yd^3) of mixed TRU waste in storage (DOE 1995gg). Mixed TRU waste has been stored since 1971. The hazardous components of TRU waste are not well defined. Activities to improve characterization of mixed TRU waste are the subject of a revised waste analysis plan that was submitted to the New Mexico Environment Department in March 1995. Activities to improve storage of these wastes are the subject of a separate compliance order. The preferred option to meet *Federal Facility Compliance Act*

requirements follows the DOE national policy on mixed TRU waste, which is shipment to WIPP. Table H.2.5–1 provides information about the mixed TRU waste streams at LANL that are expected to go to WIPP.

The LANL TRU Waste Certification Plan specifies all required information for certification. This information on certifiable/certified TRU waste that is required for transportation, for completion of the WIPP data package, and for certification is supplied by the waste generator. Uncertified waste packages, primarily stored in drums and crates, will be repackaged and treated when possible to meet the WIPP Waste Acceptance Criteria. Table H.2.5–2 describes the current and planned TRU and mixed TRU waste treatment capability at LANL. Table H.2.5–3 shows TRU and mixed TRU waste storage at LANL.

Special modes have been created for storing high beta-gamma active hot-cell wastes (remote-handled TRU wastes), for wastes containing more than 1 gram of plutonium-238, and for the TRU cement paste previously generated at the TA-21 Liquid Waste Treatment Plant. The hot-cell waste is handled remotely and stored in modified shafts. Because the waste is actually below ground during storage, little additional shielding is needed. The storage array currently employed is compatible with the remote-handled canister now approved for WIPP disposal.

The following LANL facilities treat TRU wastes:

- **Radioactive Liquid Waste Treatment Technical Area 50 (TA-50, Room WM-66).** This facility consists of holding/accumulation, neutralization, precipitation, settling, immobilization, and certification for aqueous wastes. The sludge produced is dewatered to 30- to 40-percent solids, placed in lined 208-L (55-gal) drums, and forwarded to TA-54, Area G for storage.

- **Plutonium Facility Solidification (TA-55).** This facility immobilizes liquid and particulate process residues in cement. The solidified product from the process is WIPP-certifiable TRU waste. It is sent to TA-54, Area G for storage.

- **Size Reduction Facility (WM-69).** This facility is designed to repackage and reduce the volume of various types of metallic waste items such as glove boxes, process equipment, and duct work.

- **Drum Preparation Facility.** This facility would be used to clean retrieved drums of TRU waste. Modifications are currently in final design. Drums coated with a "grease" to enhance long-term storage capability would be steam-cleaned and integrity checked before transfer to the waste preparation or transportation facilities. A RCRA Part B Permit application has been submitted to operate the facility. At the present time, there are no drums being cleaned in the drum preparation facility.

- **Transuranic Waste Treatment Facility.** This is a planned but not funded facility. The multiprocess facility would be used for processing LANL legacy TRU waste to meet WIPP certification requirements. Hot-cell capability would exist to process remote-handled waste. The facility would handle currently generated wastes from present and future environmental restoration/corrective actions; and legacy waste from storage and previously treated wastes.

The following LANL facilities store TRU wastes:

- **TA-54-153, TA-54-48 Transuranic Storage Pad (Building 153).** This unit is a steel frame tension support structure on a curbed asphalt pad. It would be used for damaged fiberglass reinforced plastic coated boxes once retrieved from the current storage configurations. Initial repairs would be made to the containers prior to shipment to onsite processing facilities. This unit is 95 percent full.

- **Corrugated Metal Pipe Storage (Pit 29).** This waste stream is no longer generated at LANL. During 1986, the 158 TRU corrugated metal pipes stored at TA-21, Area T, were retrieved, decontaminated, and moved to TA-54, Area G, for

storage. They were placed horizontally in the upper layer of Pit 29. Accepted waste streams are corrugated metal pipes and cemented sludge.

- **Storage Holding Shed (MD-8).** This unit is used for TRU waste. This unit is RCRA-permitted, but currently does not have any waste stored in it.

- **TRU Shafts (Various).** High beta-gamma active TRU hot-cell wastes are handled remotely and stored in modified shafts. Because the waste is below ground during storage, little additional shielding is needed.

- **TRU Storage Pads (Pads 1, 2, 4, Pit 9).** Drums are stacked with other TRU wastes on asphalt pads and covered with 1 to 2 m (3 to 7 ft) of earth backfill.

- **TRU Storage Trenches (Trenches A, B, C).** Through 1985, the high activity plutonium-238 wastes were routinely packaged in 114-L (30-gal) drums and placed in concrete casks for storage. Drums of combustible and noncombustible waste were placed in separate casks. The casks were sealed with asphalt and then covered with earth.

- **New Domes, TA-54-224, 283.** Operational soon.

Low-Level Waste. Both liquid and solid LLW are generated and managed at LANL. In 1993, approximately 2,694 m^3 (3,524 yd^3) of solid LLW were generated (as packaged for treatment, storage, and disposal, not including process wastewater). LLW process wastewater generation in 1993 was 21,400 m^3. Liquid LLW is generated from many areas throughout LANL. Major generators are the Chemistry-Metallurgy Building (TA-3), TA-21 Site, Radiochemistry (TA-48), and Plutonium Processing (TA-55). LANL has two onsite liquid LLW treatment facilities. The liquid LLW treatment facilities include a chemical treatment and ion-exchange plant and a 132,659 m^3/yr chemical treatment plant. Significant waste-generating processes for solid LLW are concentrated in nine TAs: TA-2, Omega Site; TA-3, South Mesa (mainly the Chemistry and Metallurgy Research Building and the Sigma Complex); TA-21, DP-Site; TA-35, Ten-Site; TA-46, WA-Site; TA-48, Radiochemistry Laboratory; TA-50, Waste Management Site; TA-53, Meson Physics Facility; and TA-55, Plutonium Facility.

Solid LLW, such as paper, plastic, glassware, and rags, are separated into compactible and noncompactible materials by the waste generators. Compactible waste is solid waste that consists of trash-type materials such as paper, plastic, rubber, and small items of glassware and small items such as short lengths of pipe conduit and small pieces of wood or sheet metal. Excluded are larger noncompactible items, waste chemicals, free or absorbed liquids, biological waste, pressurized containers, powders, and other particularly hazardous materials.

LLW noncompactible items such as large equipment and much of the D&D wastes generally are not packaged but delivered to the burial site in covered or enclosed vehicles. Short-term storage may occur at treatment or disposal facilities to accumulate a required quantity of waste for an operation to be conducted effectively. Area G, situated in Mesita del Buey in TA-54, is the active burial and storage site for solid LLW at LANL. The area has been used since 1957. Burial facilities within the area include pits and shafts of varying dimensions. Most solid LLW waste generated at LANL is buried in large pits ranging in size from 122 to 183 m (400 to 600 ft) long, 8 to 30 m (26 to 98 ft) wide, and 8 to 20 m (26 to 66 ft) deep. The current disposal facility has a remaining capacity of 22,000 m^3 (28,770 yd^3). At current operational generation rates and implementation of waste minimization, Area G has an operational life of 10 years. However, if environmental restoration activity cleanups are accelerated as presently planned, Area G will reach its useful design life by the end of 1997. Continued construction at Area G is dependent on decisions made in conjunction with the LANL Site-Wide EIS and DOE Waste Management PEIS. As an alternative to the continued construction at Area G, LANL is exploring other options for the disposal of LLW in the future (e.g., NTS) (DOE 1995q:NM 23).

Mixed Low-Level Waste. Under the *Federal Facility Compliance Act*, DOE is required to develop a site treatment plan for mixed wastes at LANL. The site treatment plan is intended to bring LANL into compliance with land disposal restrictions storage

prohibitions under the *New Mexico Hazardous Waste Act* and RCRA. On March 31, 1995, DOE submitted its proposed site treatment plan to the New Mexico Environment Department for review, public comment, and approval. On October 4, 1995, a Compliance Order was issued by the State of New Mexico requiring LANL to comply with the site treatment plan for the treatment of mixed wastes at LANL. The Compliance Plan Volume of the site treatment plan provides overall schedules for achieving compliance with the RCRA storage and treatment requirements, a schedule for the submittal of applications for permits, construction of treatment facilities, technology development, offsite transportation for treatment, and the treatment of mixed wastes in full compliance with the *New Mexico Hazardous Waste Act* and RCRA. An annual update to the site treatment plan is required.

LANL has approximately 600 m^3 (785 yd^3) of mixed LLW in storage. The waste is made up of just over 5,000 separate items that have been combined into 30 treatability groups, each with a preferred treatment option as shown in table H.2.5–4. LANL just completed recharacterizing the mixed LLW as required by the Federal Facility Compliance Agreement; the recharacterization resulted in a significant decrease in the volume reported in past documentation. Over 1,200 mixed LLW items (approximately 14 m^3 [18.3 yd^3]) are suspect for radioactive contamination. A field sort, survey, and decontamination operation will determine whether or not these wastes are contaminated with radioactivity. If not, they will be treated at commercial offsite facilities. If contaminated, they will be handled with the preferred option identified for that treatability group.

Five-year projections estimate that approximately 108 m^3 (141 yd^3) of mixed LLW would be generated at LANL. Almost all of this waste would result from small-scale R&D projects. Each project would be reviewed for waste minimization and waste treatment, storage, and disposal requirements.

The large variety and relatively small volumes of waste require a substantial array of treatment options. Table H.2.5–5 summarizes LLW and mixed LLW treatment capability at LANL. The treatment of mixed LLW is built around two major components: using offsite commercial treatment or treatment available at other DOE sites, and mixed waste treatment skids that are being designed to treat onsite hazardous and mixed waste streams that are not amenable to offsite treatment. LANL has one existing facility designed to treat mixed waste, the lead decontamination trailer.

A commercial lead decontamination unit has been purchased and located at TA-50. The treatment process is applicable to lead shapes with surface contamination. The unit would be used to decontaminate lead bricks to allow recycling by using an abrasive slurry of water, blasting media, and air. A lead sulfide sludge would be produced which would be solidified for disposal.

The scintillation vial crusher is a standard crusher with a vibrating screen to separate the broken vial glass from the liquid waste. This unit crushes the vials allowing separation of the vial from the liquid. The glass is disposed of as LLW, and the liquid is collected for further treatment. The unit does not rinse vial solid residues.

The following LANL facility would treat mixed LLW:

- **Reactive Waste Treatment.** A wet chemical process would be used to handle reactive mixed wastes, including pyrophoric uranium, sodium metal, and lithium hydride. The process would create a nonhazardous metal salt that would be solidified. Feed materials are limited to chips and powders. Pieces must be smaller than 0.3 m (1 ft) in diameter.

Table H.2.5–6 describes mixed LLW storage at LANL. Table H.2.5–7 summarizes waste disposal at LANL. LANL currently has 1,700 drum equivalents of mixed LLW in storage at TA-54, Areas G and L. Additional container storage facilities exist to support research activities at other areas at the laboratory including TAs -3, -16, -21, -50, and -55. Wastes are stored in compliance with 40 CFR 265 (and, in some cases, Part 264) requirements. To comply with the Federal Facility Compliance Agreement, schedules to complete facility upgrades that address 40 CFR 264 permitted standards and/or identified best management practices were submitted to EPA in September 1994. Several upgrades have been completed. For TA-55, a Part B Permit application addressing storage requirements under 40 CFR 264 is currently in development.

The storage of mixed wastes at Areas L and G complies with requirements of 40 CFR 265, Subpart I, the interim management standards that currently apply to these units. LANL believes that the Area G storage facility also generally complies with the requirements of 40 CFR 264. Both facilities are being upgraded, as necessary, to comply with 40 CFR Part 264 requirements before the permit is issued for these units, which is not anticipated to occur before 1998.

The following LANL facilities are used for storage of mixed LLW:

- **Low-Level Waste Shaft (Shaft 145).** Tritiated waste (>20 mCi/m^3 [740 MBq/m^3]) has been placed in asphalt lined or encapsulated drums and then placed in shafts lined with corrugated metal pipe at Area G. This shaft has been removed from the RCRA Permit and is no longer considered a mixed waste shaft. Shaft 145 is now an LLW shaft.

- **Lead Stringer Shafts (Shaft 35).** The shafts are 9.14 m (30 ft) deep by 1.83 m (6 ft) in diameter and lined with corrugated pipe located at Area L. The stringers are approximately 7.62 m (25 ft) by 0.15 m (0.5 ft) by 0.2 m (0.7 ft) hollow steel columns filled with a concrete/lead mixture. The wastes were generated at Los Alamos Meson Physics Facility.

- **TA-21-61.** Used during the 1980s for storage of PCB wastes, this building has a large diked area for waste storage. The floor is sealed with an epoxy paint. In 1990, two drums of liquid mixed LLW were stored in this facility. In 1991, the RCRA Part A application was modified identifying this facility as an interim status storage facility for mixed LLW. No mixed LLW are presently stored in this facility. LANL anticipates closing this unit in 1996.

- **Mixed Waste Dome.** Solid mixed LLW is stored primarily at Area G in Building 49. This facility contains a bermed (curbed) asphalt pad with a tension support dome structure (18.29 m by 134.11 m) (60 ft by 440 ft).

- **Area L Gas Cylinder Storage.** The RCRA Part B application for this facility was approved November 9, 1989. Accepted waste streams are legacy waste compressed gas cylinders.

- **Mixed Waste Berm.** Liquid mixed LLW is stored at TA-54, Area L. This storage area has an approximate 378,540-L (100,000-gal) capacity.

Hazardous Waste. LANL produces a wide variety of hazardous wastes. Small volumes of all chemicals listed under 40 CFR 261.33 could be generated as a result of ongoing research. Primary laboratory sites for basic and applied chemistry R&D generate typical chemical wastes consisting primarily of laboratory reagent chemicals, pump oil, solvents, test samples, and miscellaneous laboratory wastes. Significant volumes of beryllium, lithium hydride, and magnesium turnings are generated from the main shop department. Plating solutions containing chromates and cyanides, acid or base wastes heavily contaminated with copper, and nitric and sulfuric acid wastes are also generated. All developer, ferric chloride, and sodium hydroxide hazardous wastes are sent out of state for incineration. Fixer photo-wastes undergo metals recycling for silver and other precious metals. Nearly all of LANL's chemical waste is treated at commercial offsite facilities, but LANL does perform volume reduction for some waste (e.g., crushing scintillation vials) and treatment of barium sands. In the future, these hazardous wastes, which cannot be handled by commercial facilities, will be treated at yet to be determined offsite locations. Table H.2.5–8 shows hazardous waste quantities shipped offsite from LANL in 1994. Table H.2.5–9 lists LANL hazardous waste treatment capability. Table H.2.5–10 describes LANL hazardous waste storage capability.

HE waste is generated during processing and testing of various HE materials. Processing, which includes pressing, machining, and casting HE, produces pieces of HE, chips, machine cuttings, and powder. The chips, cuttings, and powder usually are in the form of waterborne suspensions, collected in specially designed accumulating and settling sump tanks. Wastes also consist of materials contaminated

with HE: paper, oils, solvents, wood, machine tools, fixtures, and so forth. Chemically the wastes consist of cyclotetramethylenetetranitramine, cyclotrimethylenetrinitramine, trinitrotoluene, pentaerythritoltetranitrate, triaminotrinitrobenzene, ammonium nitrate, barium nitrate, boric acid, nitrocellulose, tetryl, nitroguanidine, and various plastic binders.

All HE hazardous wastes and potentially contaminated HE waste are picked up and delivered to the TA-16 (S-Site) incinerator or flash pad where it is burned. Treated ash residue that is nonhazardous is disposed of in the industrial non-RCRA landfill, TA-54, Area J. Any residue with hazardous constituents remaining is shipped offsite to a commercial RCRA-permitted disposal facility.

HE wastewater is treated by gravity settlement in a sump and then discharged from NPDES-permitted outfalls. Initially, there were 21 such outfall discharges from widespread TAs that process HE. Waste minimization efforts have reduced the number of outfalls from 21 to 2. Dissolved constituents are not removed by this treatment. As a result, there are often compliance issues associated with the NPDES permit. LANL is under Administrative Order from EPA to treat all HE wastewater by 1997, and LANL has agreed to this requirement. To meet this obligation, LANL is developing a HE wastewater treatment facility that will collect and treat these wastewaters with stepped filtration. The ultimate goal for this facility is zero discharge with complete recycling of the system water. Construction is scheduled for completion in 1997 (DOE 1995q:NM 22).

All hazardous waste treatment, storage, and disposal facilities at LANL are either fully permitted, have interim status, or are operating pursuant to enforceable agreements with the regulators while other waste management facilities are being developed. LANL does not landfill RCRA hazardous waste onsite, but contracts with certified transporters to deliver hazardous waste to commercial RCRA-permitted disposal facilities. Before waste is sent offsite, the potential disposal facility is inspected by LANL personnel. Operating records and permits are also reviewed. LANL has an EPA Letter of Authorization allowing disposal of PCB-contaminated articles at the TA-54, Area G Landfill.

TA-54, Area L, is the waste transfer, packaging, and storage unit for accumulating, packaging, and greater-than-90-day storage of RCRA hazardous waste. Concrete containment structures and modular storage buildings are located at Area L. These facilities are used for accumulating, packaging, and storing waste containers generated throughout LANL. Hazardous waste containers generated at the various laboratories are routinely delivered to the waste transfer, packaging, and storage facilities.

Thermal Treatment Facilities at Technical Area-16. Four types of open burn units are at the TA-16 burning ground: a flash pad, where any HE contamination is removed from excess equipment or scrap generated within the TA; two burn pads for destruction of solid HE material; a pad with trays in which HE-contaminated waste oil is burned; and two pressure vessels for reacting HE-contaminated sludge.

The flash pad area is covered with sand. Material to be flashed is placed on the pad with any necessary additional fuel to maintain the burn until all HE has been reacted. The scrap material is then handled as solid nonhazardous waste. Because the burn pad sand may contain toxic characteristic barium, it is put in drums, stored, and managed as a hazardous waste until sampling and analysis are complete. Burn pad sand that is toxic characteristic for barium is treated at TA-54, Area L, to render it nonhazardous.

The two burn pads are used to destroy solid chunks of excess or off-specification HE and machine turnings. The material is placed on a sand-filled steel table lined with refractory brick and then ignited. Used oil and/or solvent that may be contaminated with HE is poured into metal trays lined with fire brick. The trays are in a sand-filled metal tray. The oil is ignited using a remotely operated "electric match." Approximately 374 L (99 gal) of oil are burned each month.

HE-contaminated washwater is collected in sumps at HE fabrication facilities in several TAs. HE settles out of the washwater, is collected in a vacuum truck, and is taken to TA-16 for treatment. Up to 1,650 kg (3,638 lbs) of sludge can be burned in the pressure vessels at one time. Processing liquid effluent is sent to a nearby carbon-filter wastewater treatment unit (TA-16). Treated effluent is regulated by an NPDES permit.

Thermal Treatment Facilities at Technical Areas -14, -15, -36, and -39. Open detonation sites for destruction of excess or waste HE are at TAs -14, -15, -36, and -39. These sites are used routinely to detonate scrap HE, failed experimental detonations, unneeded classified explosives shapes, and small quantities of reactive chemicals. These sites consist of detonation points on the open ground, often in a small canyon. Material to be detonated is placed on sand or on a wooden table at the firing point and detonated with a remote firing mechanism.

Industrial Incinerator at Technical Area 16. A baffled single-chamber industrial incinerator, equipped for combustion of potentially HE-contaminated trash and machine oil, is located outdoors in the northeastern part of TA-16. The incinerator burns potentially HE-contaminated paper, cardboard, wooden boxes, and occasionally a limited volume of potentially HE-contaminated machine oil. The industrial incinerator does not burn wastes other than those permitted by 40 CFR 264.340(b)(i), (ii), (iii), or (iv) [NMHWMR 206.D.8a(2)(a)(i), (ii), (iii), or (iv)]. Emissions from the incinerator conform to Federal and state standards.

Nonhazardous Waste. Nonhazardous wastes are generated routinely and include general facility refuse such as paper, cardboard, glass, wood, plastics, scrap, metal containers, and dirt and rubble. In 1993, 5,453 m^3 (7,132 yd^3) of solid nonhazardous wastes were generated by LANL (LANL 1994b:6). Nonhazardous wastes are segregated and recycled whenever possible. Trash is accumulated onsite in dumpsters, which are emptied on a regular basis by a commercial waste disposal firm and taken to the county sanitary landfill.

Solid sanitary waste generated by LANL is currently disposed of at the Sandia Canyon Site (TA-61) on East Jemez Road. Owned by DOE, this site serves the landfill needs of both LANL and Los Alamos County. Approximately one-third of the domestic solid waste disposed of at the county landfill originates from LANL. The county has operated this landfill under a Special Use Permit from DOE since 1971. The existing sanitary landfill is expected to reach the end of its useful life by 2008. At that time, either a new landfill will have to be constructed or provisions made for offsite disposal.

Administratively controlled waste is not regulated by RCRA and TSCA but is deemed by LANL to be inappropriate for disposal at the Los Alamos County sanitary landfill. Examples are classified computer equipment, magnetic tapes, or any wastes controlled for national security purposes. These wastes are disposed of in the Area J solid waste landfill at TA-54, which is regulated by the New Mexico Solid Waste Bureau, as is the sanitary landfill. Future plans for disposal will depend on the future strategy for sanitary waste disposal. If not, an alternative site will be identified when Area J reaches capacity (DOE 1995q:NM 24).

A new LANL Sanitary Wastewater Treatment Plant and Collection System have been completed to replace 7 existing wastewater treatment facilities and 30 existing septic tanks. The new treatment plant enables reuse of the treated wastewater for nondrinking water uses such as cooling and irrigation. The plant and collection system is designed to meet the requirements of LANL's existing Federal Facility Compliance Agreement.

Waste Category	Storage Locations	Storage Method	RCRA Code	Inventory as of December 31, 1994 (m^3)	Projected Generation (1995-1999) (m^3)
Mixed scrap metal	TA-54 Area G Pit 9, TA-54 Area G 54-153, TA-54 Area G 54-48, TA-54 Area G Pad 1,2, and 4	Container (covered), Container (retrievably buried)	D008	2,206.38	25
Cemented process sludge	TA-54 Area G Pit 9, TA-54 Area G 54-153, TA-54 Area G 54-48, TA-54 Area G Pad 1,2, and 4	Container (covered), Container (pad), Container (retrievably buried)	D007 D008, D009, F001, F002, F005	3,052.97	100
Solidified aqueous waste	TA-54 Area G Pit 9, TA-54 Area G 54-153, TA-54 Area G 54-48, TA-54 Area G Pad 1,2, and 4	Container (covered), Container (pad), Container (retrievably buried)	F001	1,277.42	100
Combustible debris	TA-54 Area G Pit 9, TA-54 Area G 54-153, TA-54 Area G 54-48, TA-54 Area G Pad 1,2, and 4	Container (covered), Container (retrievably buried)	D007,D008, D019, D040, F001, F002, U080	252.43	125
Noncombustible debris	TA-54 Area G Pit 9, TA-54 Area G 54-153, TA-54 Area G 54-48, TA-54 Area G Pad 1,2, and 4	Container (covered), Container (pad), Container (retrievably buried)	D008, D019, D040	213.06	125
Solidified inorganic and organic process solids	TA-54 Area G Pit 9, TA-54 Area G 54-153, TA-54 Area G 54-48, TA-54 Area G Pad 1,2, and 4	Container (covered), Container (pad), Container (retrievably buried)	D006, D007, D008, D019, D021, D039, F001, F002, F003	527.65	150
Glove box and ducting metallic waste	TA-54 Area G Pit 9, TA-54 Area G 54-153, TA-54 Area G 54-48, TA-54 Area G Pad 1,2, and 4	Container (covered), Container (pad), Container (retrievably buried)	D007, D008	142.46	100
Mixed scrap metal	TA-54 Area G Remote shafts	Remote shafts	D008	2.12	8
Noncombustible debris	TA-54 Area G Remote shafts	Remote shafts	D008	15.84	8
Metallic waste	TA-54 Area G Pad 1,2, and 4	Container (covered)	D008	0.567	No future generation
Total				7,690.897	741

Source: DOE 1995gg.

TABLE H.2.5–2.—*Transuranic and Mixed Transuranic Treatment Capability at Los Alamos National Laboratory* [Page 1 of 2]

Treatment Unit	Treatment Method	Input Capability	Output Capability	Design Feedrate	Comment
Plutonium Facility solidification (TA-55)	Encapsulation	Liquid, solid and sludge mixed TRU waste, TRU waste, hazardous waste. Solid type: filters, glass, metal, paper, plastic, rags, rubber, corrosive, listed, reactive, TCLP	Solid mixed TRU and TRU cement; corrosive, listed, reactive, TCLP. Contact-handled shielded containers to TA-54, Area G storage	0.08 m^3/hr	Operational; the solidified product from the process is WIPP certifiable TRU
Pretreatment Plant (Rm. WM-66, TA-50-1)	Liquid/solid separation, sedimentation, neutralization, precipitation	Liquid mixed TRU waste. Specific waste: listed, corrosive, TCLP. Contact-handled	Liquid TRU to Radioactive Liquid Waste Treatment (TA-50-1), TRU sludge-solidified (cement) to Certified Waste Pad storage. Specific Waste: listed, corrosive, TCLP. Contact-handled	5.70 m^3/hr	Operational
Size Reduction Facility (WM-69)	Size reduction	Solid mixed TRU waste, TRU waste, LLW. Solid type: equipment, filters, glass, metal, other, paper, plastic, rags, rubber	Size reduced TRU metal to storage LANL TA-54, Area G; TRU certified mixed waste and certified TRU waste to storage Certified Waste Pad	1.36 m^3/hr	Operational
TRU Waste Treatment Facility	Decontamination, solidification, repackaging, shredding, size reduction	Solid and sludge mixed TRU waste, TRU waste. Solid type: filters, glass, labpack, metal, paper, plastic, rags, rubber. Specific waste: corrosive, reactive, TCLP. Contact-handled and remote-handled	Solid and sludge mixed TRU waste, TRU waste. Solid type: filters, glass, labpack, metal, paper, plastic, rags, rubber. Specific waste: TCLP. Contact-handled and remote-handled TRU certified mixed waste and TRU certified waste disposal to WIPP	Planned	Planned but not funded Date available: January 1, 2000
Radioactive liquid waste treatment (TA-50-1)	Adsorption, liquid/solid separation, coagulation, filtration, neutralization, precipitation	Liquid mixed TRU waste, LLW, corrosive	Liquid sludge, mixed LLW, LLW. Specific waste: listed liquid effluent to storage; vacuum filter sludge to storage	30 m^3/hr	Operational; NPDES Permit

TABLE II.2.5–2.—*Transuranic and Mixed Transuranic Treatment Capability at Los Alamos National Laboratory* [Page 2 of 2]

Treatment Unit	Treatment Method	Input Capability	Output Capability	Design Feedrate	Comment
Radioactive Liquid Waste Treatment Plant	Neutralization, precipitation	Liquid mixed TRU waste, mixed LLW, LLW, hazardous waste, corrosive	Gas, liquid, sludge, solid mixed TRU waste, TRU waste, mixed LLW, LLW, hazardous waste, sanitary waste Solid LLW to disposal TA-54; Solid TRU to storage TA-54; Solid TRU to disposal WIPP	600 m^3/hr	Planned but not funded. Date available: January 1, 2004. Will replace the existing treatment plant, TA-50-1, including the pretreatment plant which cannot realistically be modified or upgraded to meet expected ES&H requirements
Drum Preparation Facility	Decontamination	Solid mixed TRU waste, TRU waste, hazardous waste. Solid type: Construction/D&D debris, equipment, filters, glass, metal, paper, plastic, rags, rubber, soil. Specific waste: reactive, listed, ignitable, TCLP, corrosive	Liquid, solid and sludge mixed TRU waste, TRU waste, LLW	0.50 m^3/hr	Operational

Note: TCLP - Toxicity Characteristic Leaching Procedure.
Source: DOE 1994k.

TABLE H.2.5–3.—*Transuranic and Mixed Transuranic Waste Storage at Los Alamos National Laboratory*

Storage Unit	Input Capability	Design Capacity[a] (m^3)	Comment
Certified waste pad	Solid mixed TRU waste, TRU waste, hazardous waste. Solid type: glass, metal, paper, plastic, rags, rubber, soil. Specific waste: corrosive, ignitable, listed, reactive, TCLP. Contact-handled	570	Operational
TRU storage pad 1	Solid and sludge mixed TRU waste, TRU waste; metal, other; listed, TCLP.	Under evaluation per LANL site treatment plan	Operational
TRU storage pad 2	Solid and sludge mixed TRU waste, TRU waste; hazardous waste; other; ignitable, listed, TCLP	Under evaluation per LANL site treatment plan	Operational
TRU storage pad 4	Solid and sludge mixed TRU waste, TRU waste; hazardous waste; other; listed, TCLP	3,000	Operational
Storage holding shed, MD-8	Solid mixed TRU waste, TRU waste, hazardous waste. Specific waste: corrosive, ignitable, listed, reactive, TCLP. Contact-handled	6.25	Operational
TRU storage trench A	Solid mixed TRU waste, TRU waste, hazardous waste. Specific waste: corrosive, ignitable, listed, reactive, TCLP	Under evaluation per LANL site treatment plan	Operational
TRU storage trench B	Solid mixed TRU waste, TRU waste, hazardous waste. Specific waste: corrosive, ignitable, listed, reactive, TCLP	Under evaluation per LANL site treatment plan	Operational
TRU storage trench C	Solid mixed TRU waste, TRU waste, hazardous waste. Specific waste: corrosive, ignitable, listed, reactive, TCLP	Under evaluation per LANL site treatment plan	Operational
TRU shafts	Solid mixed TRU waste, TRU waste. Solid type: equipment, glass, metal, paper, plastic, rags, rubber, soil. Specific waste: listed. Contact-handled, remote-handled	357	Operational
TRU storage pad, pit 9	Solid and sludge mixed TRU waste, TRU waste, hazardous waste. Specific waste: listed, TCLP	Under evaluation per LANL site treatment plan	Operational
Short-term enhanced storage	Solid mixed TRU waste, TRU waste. Specific waste: listed, TCLP. Remote-handled	Under evaluation per LANL site treatment plan	Planned and funded
Corrugated metal pipes storage, pit 29	Solid and sludge mixed TRU waste, TRU waste, hazardous waste. Specific waste: listed. Contact-handled	418.81	Operational
New TRU storage pad, Bldg. 153	Solid mixed TRU waste, TRU waste, hazardous waste. Solid type: equipment, filters, glass, metal, paper, plastic, rags, rubber, soil. Specific waste: listed. Contact-handled	570	Operational

[a] Schedules and capacities for facilities under design or construction are subject to changes based on the availability of funds, permit issuance, and so forth. New shafts and domes can be built as needed. Only one half of the 64-acre site is used for aboveground storage.

Source: DOE 1994k.

TABLE II.2.5-4.—*Mixed Low-Level Waste Streams at Los Alamos National Laboratory* (Page 1 of 2)

Treatability Group	Number of Items	Net Volume (m^3)	Projected Net Volume (1995-2000) (m^3)	Preferred Option	Alternate Option	Treatment Site
IPA wastes	104	15.89	0.01	Commercial thermal treatment	Hydrothermal	offsite
Scintillation fluids	18	2.47	4.0	Commercial thermal treatment	Hydrothermal	offsite
Lead blankets	4	0.74	0.2	Commercial treatment	Macroencapsulation	offsite
Soil with heavy metals	59	10.53	2.0	Commercial treatment	Chelator extraction	offsite
Environmental restoration soils	36	39.32	unknown	Commercial treatment	Macroencapsulation	offsite
Aqueous organic liquids	45	1.65	0.5	Evaporative oxidation	Hydrothermal	onsite
Halogenated organic liquids	385	16.58	5.5	Hydrothermal	DETOX process	onsite
Nonhalogenated organic liquids	275	14.34	10.0	Hydrothermal	DETOX process	onsite
Bulk oils	28	3.75	3.0	Hydrothermal	DETOX process	onsite
Polychlorinated biphenyls wastes with *Resource Conservation and Recovery Act* components	4	0.74	0.2	Hydrothermal	DETOX process	onsite
Organic-contaminated combustible solids	307	28.32	7.0	Thermal desorption	Under evaluation per LANL site treatment plan	onsite
Combustible debris	83	13.82	1.5	Macroencapsulation	Under evaluation per LANL site treatment plan	onsite
Aqueous wastes with heavy metals	203	1.85	1.0	Chemical plating waste skid	Evaporative oxidation	onsite
Corrosive solutions	162	1.36	0.5	Chemical plating waste skid	Evaporative oxidation	onsite
Aqueous cyanides, nitrates, chromates, and arsenates	15	0.13	0.01	Chemical plating waste skid	Evaporative oxidation	onsite
Water-reactive wastes	78	6.03	0.2	Water-reactive metals skid	Under evaluation per LANL site treatment plan	onsite
Compressed gases requiring scrubbing	13	0.35	0.1	Gas scrubbing skid	Under evaluation per LANL site treatment plan	onsite
Compressed gases requiring oxidation	6	0.08	0.1	Gas oxidation skid	Under evaluation per LANL site treatment plan	onsite

TABLE H.2.5–4.—*Mixed Low-Level Waste Streams at Los Alamos National Laboratory* [Page 2 of 2]

Treatability Group	Number of Items	Net Volume (m^3)	Projected Net Volume (1995-2000) (m^3)	Preferred Option	Alternate Option	Treatment Site
Organic-contaminated noncombustible solids	80	7.82	8.0	Thermal desorption	Under evaluation per LANL site treatment plan	onsite
Elemental mercury	45	0.5	0.05	Amalgamation	Under evaluation per LANL site treatment plan	onsite
Activated or inseparable lead	74	15.6	1.0	Macroencapsulation	Under evaluation per LANL site treatment plan	onsite
Noncombustible debris	41	5.62	3.0	Macroencapsulation	Under evaluation per LANL site treatment plan	onsite
Inorganic solid oxidizers	55	0.2	0.05	Hydrothermal	Under evaluation per LANL site treatment plan	onsite
Lead wastes	186	51.44	10.0	Under evaluation per LANL site treatment plan	Under evaluation per LANL site treatment plan	Under evaluation per LANL site treatment plan
Mercury wastes	63	18.3	25.5	Under evaluation per LANL site treatment plan	Under evaluation per LANL site treatment plan	Under evaluation per LANL site treatment plan
Compressed gases	10	1.25	2.0	Under evaluation per LANL site treatment plan	Under evaluation per LANL site treatment plan	Under evaluation per LANL site treatment plan
Biochemical laboratory wastes	9	1.34	unknown	Under evaluation per LANL site treatment plan	Under evaluation per LANL site treatment plan	Under evaluation per LANL site treatment plan
Dewatered treatment sludge	1,288	268.17	unknown	Under evaluation per LANL site treatment plan	Under evaluation per LANL site treatment plan	Under evaluation per LANL site treatment plan
Nonradioactive or suspect waste items	1,250	14.24	9.5	Sort, survey, and decontaminate	Appropriate treatment	onsite
Surface-contaminated lead	125	56.2	12.5	Lead decontamination trailer	Under evaluation per LANL site treatment plan	onsite
Lead requiring sorting	48	9.97	0.0	Sort based on treatment	Under evaluation per LANL site treatment plan	onsite
Total	5,099	608.61	107.9			

Source: LANL 1995a.

TABLE II.2.5–5.—*Low-Level Waste and Mixed Low-Level Waste Treatment Capability at Los Alamos National Laboratory*

Treatment Unit	Treatment Method	Input Capability	Output Capability	Design Feedrate[a]	Comment
Lead decontamination trailer, TA-50	Washing	Solid LLW, TCLP	Solidified lead sulfide to disposal TA 54, Area G	10 kg/hr	Operational
Low-Level Waste Compactor, TA-54, Bldg. 2	Compaction	Solid LLW	Compacted solid LLW	182 t	Replaces existing 45-t compactor
Chemical Plating Waste Treatment Pilot Unit, Chemical TA-50, Bldg. 37	Neutralization, oxidation, precipitation	Liquid mixed LLW; listed; contact-handled	Solidified metal sludge and solidified plating liquid; to disposal Mixed Waste Storage and Disposal Facility, TA-67	31 m^3/yr	Planned–150 55-gal drums per year
Radioactive liquid waste treatment, TA-21-257	Compaction, coagulation, sedimentation, neutralization, precipitation	Liquid mixed LLW, LLW; corrosive; contact-handled	Cemented sludge; to storage mixed waste dome, TA 54-49; liquid purified supernate; to treatment Radioactive Liquid Waste Treatment, TA-50-1	28.50 m^3/hr	Operational
Reactive waste treatment	Oxidation	Solid mixed LLW, LLW, hazardous waste; reactive metal	Solidified LLW metal salts to disposal TA-54, Area G	2.00 kg/hr	Planned but not funded
Scintillation vial crusher, Area L	Crushing and grinding	Liquid and solid mixed LLW; listed, ignitable, contact handled	Solid mixed LLW empty drums to disposal TA-54, Area G, Pit # 37; solvent contaminated process debris to storage mixed waste dome, TA-54-49	0.33 m^3/hr	Operational
TA-15 Open Detonation Facility	Detonation	Liquid and solid mixed LLW, hazardous waste, reactive, TCLP	Solid mixed LLW TCLP; ash with sand to storage TA-54, Area G storage area	Under evaluation per LANL site treatment plan	Standby mode RCRA interim status unit
TA-36 Open Detonation Facility	Detonation	Liquid and solid mixed LLW, hazardous waste, reactive, TCLP	Solid mixed LLW TCLP; ash with sand to storage TA-54, Area G storage area	Under evaluation per LANL site treatment plan	Operational

[a] For those facilities in use, this is a normal operating feedrate; for facilities under design or construction, this is a design feedrate. Schedules and feedrates for facilities under design or construction are subject to changes based on the availability of funds, results of treatability studies, and permit issuance.

Source: DOE 1994k.

TABLE H.2.5–6.—*Low-Level Waste and Mixed Low-Level Waste Storage at Los Alamos National Laboratory*

Storage Unit	Input Capability	Design Capacity[a] (m^3)	Comment
Lead stringer shaft 35	Solid LLW, metal TCLP	24	Operational
Lead stringer shaft 36	Solid LLW, metal TCLP	24	Operational
LLW waste shaft 145	Solid LLW	6.25	Operational
LLW waste shaft 146	Solid LLW	6.25	Operational
Mixed waste berm, TA-54, Area L	Liquid and solid mixed LLW, LLW, hazardous waste; metal; reactive, listed, ignitable, TCLP	Under evaluation per LANL site treatment plan	Operational
Mixed waste dome, TA-54-49	Solid sludge mixed LLW, LLW, hazardous waste; metal; corrosive, reactive, listed, TCLP	650	Operational
Mixed Waste Receiving and Storage Facility	Liquid and solid mixed LLW; listed, ignitable, TCLP	1,135	Planned and funded; Date available: June 1, 1998
Sample Management Facility, TA-3, Bldg. 371	Geologic rock and soil core samples from ER program that are potentially contaminated with radionuclides and nonradioactive contaminants including volatiles	153	Planned
TA-21-61	Liquid mixed LLW, listed, ignitable	120	Operational
TA-54, Area L gas cylinder storage	Gas mixed LLW, LLW, hazardous waste; corrosive, ignitable, listed, reactive	Under evaluation per LANL site treatment plan	Operational

[a] Schedules and capacities for facilities under design or construction are subject to changes based on the availability of funds, permit issuance, and so forth.

Note: ER - environmental restoration; TCLP - Toxicity Characteristic Leaching Procedure.

Source: DOE 1994k.

TABLE H.2.5–7.—*Waste Disposal at Los Alamos National Laboratory*

Disposal Unit	Input Capability	Capacity[a] (m^3)	Comment
Burial site - shafts, TA-54, Area G	Solid TRU waste, LLW. Solid type: construction/D&D debris, equipment, filters, glass, medical, paper, plastic, rags, rubber, soil. Contact-handled, remote-handled	51.5	Operational; Termination date: August 1, 2005
Burial site - pit 37, TA-54, Area G	Solid LLW. Solid type: construction/D&D debris, equipment, filters, glass, labpack, medical, metal, paper, plastic, rags, rubber, soil. Contact-handled Specific waste: PCBs	6,411	Operational; Termination date: December 31, 1996
Mixed Waste Disposal Facility, TA-67	Solid mixed LLW, listed	457,000	Planned and funded; Date available: December 25, 1997

[a] Schedules and capacities for facilities under design or construction are subject to changes based on the availability of funds, permit issuance, and so forth.

Source: DOE 1994k.

TABLE H.2.5–8.—*Hazardous Waste Quantities Shipped Offsite in 1994, Los Alamos National Laboratory*

Description	Number of Shipments Containing Description	Quantity (kg)	Estimated Volume (m^3) [a]
Arsenic compounds, liquid, n.o.s.	1	< 1	< 0.1
Caustic alkali liquids, n.o.s.	1	541	0.5
Combustible liquid, n.o.s.	1	299	0.3
Compressed gases, flammable, n.o.s.	8	999	2.0
Compressed gases, flammable, toxic, n.o.s.	6	542	1.0
Compressed gases, n.o.s.	6	488	1.0
Compressed gases, toxic, n.o.s.	7	1,182	2.4
Corrosive liquids, n.o.s.	52	5,808	5.8
Corrosive liquids, oxidizing, n.o.s.	2	320	0.3
Corrosive liquids, poisonous, n.o.s.	11	770	0.8
Corrosive solids, n.o.s.	2	5	< 0.1
Environmentally hazardous substances, liquid, n.o.s.	1	109	0.1
Flammable liquids, corrosive, n.o.s.	2	8	< 0.1
Flammable liquids, n.o.s.	61	3,799	3.8
Flammable liquids, poisonous, n.o.s.	15	1,383	1.4
Flammable solids, n.o.s.	25	1,872	1.2
Flammable solids, poisonous, n.o.s.	6	285	0.2
Hazardous waste, liquid, n.o.s.	65	11,003	11.0
Hazardous waste, solid, n.o.s.	96	146,344	97.6
Mercury	7	63	< 0.1
Nitrates, inorganic, n.o.s.	2	1	< 0.1
Organochlorine pesticides, solid toxic n.o.s.	1	4	< 0.1
Organophosphorus pesticides, solid, toxic, n.o.s.	1	68	< 0.1
Oxidizing substances, liquid, corrosive, n.o.s.	4	475	0.5
Oxidizing substances, liquid, n.o.s.	3	48	< 0.1
Oxidizing substances, solid, n.o.s.	1	2	< 0.1
Paint-related material	3	585	0.4
Poisonous liquids, corrosive, n.o.s.	1	5	< 0.1
Poisonous liquids, flammable, n.o.s.	5	74	< 0.1
Poisonous liquids, n.o.s.	22	882	0.9
Poisonous solids, n.o.s.	19	1,041	0.7
Refrigerant gases, n.o.s.	3	170	85.0

[a] For those shipments in which only a mass quantity was provided, a volume estimate was made based on density factors of 500 kg/m^3 for compressed gases, 1,000 kg/m^3 for liquids, and 1,500 kg/m^3 for solids.

Note: n.o.s. - not otherwise specified.

Source: DOE 1995h.

TABLE H.2.5–9.—*Hazardous Waste Treatment Capability at Los Alamos National Laboratory* [Page 1 of 2]

Treatment Unit	Treatment Method	Input Capability	Output Capability	Design Feedrate[a] (m^3/yr)	Comment
Wastewater Treatment Plant, TA-16-228	Centrifugation	Liquid hazardous waste, reactive	Liquid effluent to storage, mixed waste dome, TA-54-49 Solid spent carbon granules to treatment, TA-16 flash pad	5.70 m^3/hr	Operational; Final NPDES permit
TA-54, Area L treatment tanks	Solidification, evaporation, neutralization, precipitation	Solid hazardous waste (soil), TCLP	Sludge (solidified residue), disposal to TA 54, Area J	NA	Operational; RCRA Part B permit interim status; 1992 Volume: 378
TA-39 Open Detonation Facility	Detonation	Solid hazardous waste, reactive (filters, paper, rags, HE scrap)	Solid, TCLP, to air and soil	NA	Operational; RCRA Part B permit interim status; 1992 Mass: 44.01 kg/yr
TA-16 incinerator	Incineration	Solid hazardous waste, reactive (paper, plastic, rags, rubber, wood)	Solid, nonhazardous ash, disposal to TA-54, Area J landfill	368 kg/hr	Operational; RCRA Part B final permit
TA-16 (pressure vessels)	Filtration, open burning	Sludge hazardous waste, reactive, TCLP	Ash with sand; treatment to TA-54, Area L treatment tanks; filtered HE-contaminated wash-water; treatment to carbon-filter waste-water treatment unit	NA	Operational; RCRA Part B permit interim status; 1992 Mass: 3,068 kg/yr
TA-16 burn tables	Open burning	Solid hazardous waste, reactive, TCLP	Ash with sand; treatment to TA-54, Area L treatment tanks	NA	Operational; RCRA Part B permit interim status; 1992 Mass: 6,218 kg/yr
TA-16 flash pad	Open burning	Solid hazardous waste, reactive (glass, metal, equipment, carbon granules)	Flashed scrap and equipment, disposal to TA-54 Area J landfill	NA	Operational; RCRA Part B permit interim status; 1992 Mass: 22,455 kg/yr
TA-16 oil/solvent burn pan	Open burning	Liquid hazardous waste, ignitable, listed, reactive	Flashed to air	NA	Operational; RCRA Part B permit interim status; 1992 Volume: 1.03 m^3/yr

TABLE H.2.5–9.—*Hazardous Waste Treatment Capability at Los Alamos National Laboratory* (Page 2 of 2)

Treatment Unit	Treatment Method	Input Capability	Output Capability	Design Feedrate[a] (m^3/yr)	Comment
TA-14 open burning pad	Open burning	Solid hazardous waste, reactive (filters, paper, rags)	Solid nonhazardous ash; disposal to TA-54 Area J landfill	NA	Operational; RCRA Part B permit interim status; 1992 Volume: 0.28 m^3/yr
TA-14 open detonation pad	Detonation	Solid hazardous waste, reactive (HE scrap)	Solid hazardous waste; reactive, disposal to air and soil	NA	Operational; RCRA Part B permit interim status; 1992 Mass: 3,162 kg/yr

[a] For those facilities in use, this is a normal operating capacity; whereas, for facilities under design or construction this is a design capacity. Schedules and capacities for facilities under design or construction are subject to changes based on the availability of funds, results of treatability studies, permit issuance, and so forth.

Note: NA - not applicable; TCLP - Toxicity Characteristic Leaching Procedure.

Source: DOE 1994k.

TABLE H.2.5–10.—*Hazardous Waste Storage Capability at Los Alamos National Laboratory*

Storage Unit	Input Capability	Design Capacity[a] (m^3)	Comment
Area L storage, TA-54-31	Liquid hazardous waste, corrosive, ignitable, listed	1.67	Operational; RCRA Part B permit
Area L storage, TA-54-32	Liquid hazardous waste, reactive, corrosive, ignitable, listed	65.20	Operational; RCRA Part B permit
TA-54, Area L modular storage building	Solid hazardous waste (Labpack); corrosive, ignitable, listed, reactive	6.25	Operational; RCRA Part B permit

[a] Schedules and capacities for facilities under design or construction are subject to changes based on the availability of funds, permit issuance, and so forth.

Source: DOE 1994k.

H.2.6 Lawrence Livermore National Laboratory

The DOE Oakland Operations Office is the field organization responsible for the implementation of waste management plans at Lawrence Livermore National Laboratory (LLNL). The LLNL Hazardous Waste Management Division is responsible for preparing those plans. The Division is also responsible for processing all hazardous wastes, radioactive wastes, and mixed wastes generated at both the Livermore Site and Site 300. The Livermore Site and Site 300 do not generate or manage spent nuclear fuel or HLW. Both the Livermore Site and Site 300 are on the NPL for sites requiring environmental restoration in accordance with CERCLA and SARA. Because there is no spent nuclear fuel, HLW, or TRU waste associated with any of the proposed activities at the Livermore Site and Site 300 (secondary and case fabrication, HE fabrication, nonnuclear fabrication, NIF, and CFF), there will be no further discussion in this appendix of spent nuclear fuel, HLW, or TRU waste generation and management at the Livermore Site and Site 300.

Pollution Prevention. The *Waste Minimization and Pollution Prevention Awareness Plan* published on April 25, 1994, documents LLNL projections for present and future waste minimization and pollution prevention. The plan specifies those activities and methods used to reduce the quantity and toxicity of wastes generated at the site.

Low-Level Waste. LLNL has a relatively large inventory of noncertified LLW that must be characterized, certified, and disposed of. Most of this waste was generated between 1988 and 1993 and consists of roughly 7,000 drum equivalents. An ongoing multiphase project will ultimately conclude with the disposal of the entire LLNL legacy LLW inventory. This project includes the preparation of a waste disposal addendum to the LLNL waste disposal application that will cover legacy waste and any waste certification procedures.

Aqueous LLW is treated at Building 514, the Liquid Waste Treatment Facility. At the facility, containerized and bulk radioactive liquid wastes are transferred into one of the six 7,000-L (1,850-gal) tanks to be treated chemically. The tanks are used to treat both radioactive and mixed waste liquids. Following treatment, if the tank's contents are below established sewer discharge limits, the liquid is released to the sanitary sewer. The precipitate wastes from the chemical treatments are filtered to create a filter cake. The filter cake is then stabilized. Captured filtrate is either discharged to the sanitary sewer or retreated.

No liquid LLW is generated at Site 300. Most Site 300 solid LLW is generated from the detonation of test assemblies on firing tables. The debris consists of gravel and fragments of wood, metal, and glass; larger debris consists of tent poles and pieces of wood, steel, aluminum, concrete, plastic, glass, burlap bags, cables, and other inert testing materials. These parts are contaminated with depleted uranium and sometimes, thorium. Firing table operations have also periodically generated wastes containing tritium. LLW, including the gravel from firing table operations, is packaged in approved waste containers and transported to Building 804 for staging, pending shipment to the Livermore Site or shipment directly to NTS for disposal.

Mixed Low-Level Waste. Current inventories of mixed LLW at LLNL total approximately 457 m^3 (598 yd^3). Schedules for waste treatment vary by waste stream. Mixed waste (other than wastewater, which is treated at Building 514) is appropriately packaged and stored at the Area 514 complex or the Area 612 complex, pending establishment of a suitable onsite or offsite facility that can dispose of such waste according to applicable regulations. Descriptions of mixed waste treatment options, inventory, treatment, disposal and storage facilities for LLW, and mixed LLW are listed in tables H.2.6–1, H.2.6–2, and H.2.6–3.

Some mixed waste can be chemically or physically treated at LLNL. Existing treatment for mixed wastes includes neutralization, flocculation, chemical reduction and oxidation, precipitation, separation, filtration, solidification, size reduction, shredding, adsorption, and blending. Mixed wastes are currently treated in the Building 513 Solidification Unit, the Area 514 Wastewater Filtration Unit, and the Area 514 Wastewater Treatment Tank Farm Unit.

LLNL has requested regulatory agency approval to add centrifugation and evaporation treatment units, as well as to increase current treatment operations for

mixed wastes. Also, mixed wastes are stored in appropriate units at the Livermore Site for extended periods until they can be shipped to an approved offsite treatment and/or disposal facility. Although LLNL does not have current existing treatment units to treat its organic liquid mixed waste, it is planning to develop treatment technology for these waste streams.

The matrices of the mixed LLW to be generated in the future include aqueous liquid, homogeneous solids, organic and inorganic debris, organic liquids, reactive metals, elemental lead, high efficiency particulate air (HEPA) filters, and elemental mercury. The aqueous liquid and homogeneous solids waste streams are projected to each generate 92 percent of the mixed LLW. Organic liquids will account for almost 3 percent of the future volume and the organic/inorganic debris is projected to account for approximately 4 percent of the mixed LLW. Reactive metals, elemental lead, HEPA filters, and elemental mercury account for the remaining 1 percent.

Soils from environmental restoration activities may contain low-level radioactivity (primarily tritium and some depleted uranium at Site 300) mixed with low concentrations of VOCs and possibly some metals (i.e., cadmium, lead, chromium, copper, nickel, zinc, beryllium, and mercury) in the soil matrix. The waste would primarily be generated during drilling operations and minor excavations. Environmental restoration drilling activities at LLNL are likely to occur through 1998. The generation rate of wastes from LLNL drilling is estimated to be 20 to 50 drums per year, or approximately 17 to 42 m^3 (22 to 55 yd^3) through 1998 (LLNL 1995h:6-2).

At Site 300, liquids (groundwater) from developing, testing, and purging wells that contain tritium and VOCs as the primary contaminants could potentially be generated. The total estimated volume of potential liquid mixed waste is less than 18,927 L/yr (5,000 gal/yr). This would correspond to 76 m^3 (100 yd^3) through 1998 (LLNL 1995h:6-2). Future generation of mixed waste at Site 300 is not anticipated.

Hazardous Waste. As a research facility, LLNL generates a variety of hazardous wastes, many in relatively small quantities. Almost all buildings generate hazardous wastes, ranging from common household items such as fluorescent light tubes, batteries, and lead-based paint to solvents, metals, cyanides, toxic organics, pesticides, asbestos, and PCBs. Table H.2.6–4 lists hazardous waste quantities shipped offsite from LLNL in 1994.

LLNL presently operates five hazardous waste management facilities. These are the Area 514 Facility, Area 612 Facility, Building 233 Facility, Building 693 Facility, and Building 419 Facility. The Area 514 and 612 facilities include treatment and storage units for hazardous and mixed wastes; the Building 233 facility is a container storage unit for hazardous and mixed wastes; the Building 693 Facility is a container storage unit for hazardous wastes, but will eventually be used for the storage of both hazardous and mixed wastes; and the Building 419 Facility includes inactive treatment units that are awaiting regulatory closure.

LLNL is currently operating its hazardous waste management activities under the interim status standards of the *California Code of Regulations*, Title 22, Part 66265. A RCRA Part B Permit application has been submitted to the State of California for continued operation, and a final permit is expected in 1996. Under interim status, LLNL receives hazardous and/or mixed wastes from Site 300.

Site 300 operates two hazardous waste management units. These units are only used for the treatment and long-term storage (i.e., greater than 90-day storage) of hazardous wastes. The Building 883 container storage area is a covered storage area on the southwest side of Building 883. The facility is designed primarily to hold hazardous waste before it is transferred to the Area 612 Facility at LLNL for treatment, storage, and disposal or sent directly offsite for disposal. It is currently permitted under the RCRA Part B Permit for Site 300. Table H.2.6–5 lists hazardous waste quantities shipped offsite from Site 300 in 1994.

LLNL generates several types of medical wastes consisting of biohazardous waste and sharps (i.e., needles, blades, and glass slides) waste from biomedical research, Center for Chemical Forensics, and health services facilities. In July 1991, LLNL registered with the Alameda County Environmental Health Services as a large-quantity generator of medical waste, and submitted an application for a medical waste treatment permit. The treatment permit was issued in August 1991 and is valid through July 1996.

TABLE H.2.6–1 *Mixed Low-Level Waste Streams at Lawrence Livermore National Laboratory* [Page 1 of 2]

Waste Description	Source Description	Inventory as of January 1995 (m^3)	Total Generation 1995-1999 Projection (m^3)	Treatment Option
Organic fluids and glass	Changing R&D activities which provide liquid organic fluids in glass vials	5.5	5	Treating or plan to treat onsite
Filter cake	Rotary drum vacuum filtration of LLNL wastewaters (Building 514)	105.9	110	Treating or plan to treat onsite
Inorganic trash	Changing R&D activities which generate cleanup trash and used safety equipment such as coveralls	8.7	7	Treating or plan to treat offsite
Wash waters	Laboratory-wide R&D	68.1	1,350	Treating or plan to treat onsite
Inorganic sludges and particulates	Onsite retention tank cleaning and surface spill cleanup	2.8	5	Treating or plan to treat onsite
Scrap metal	Onsite research and maintenance including lab	15.2	5	Treating or plan to treat offsite
Lead bricks	Used and discarded lead bricks which may have been used for shielding purposes	3.9	5	Treating or plan to treat offsite
Halogenated solvent	From/by phase separation from onsite waste water treatment processes	7.1	10	Treating or plan to treat onsite
Oils	Waste oils skimmed by phase separation from onsite waste water treatment processes	3.6	8.5	Treating or plan to treat onsite
Soil-1	Soil excavated from onsite trenching activities	10.1	10	Treating or plan to treat onsite
Lithium metal	Used and discarded laboratory waste from changing R&D activities	1.0	1.0	Treating or plan to treat onsite
Oils	Draining of vacuum pumps. Onsite R&D activities which use halogenated solvents	13.7	20	Treating or plan to treat onsite
HEPA filters	Generated by onsite research activities and facility maintenance	3	15	Treating or plan to treat offsite
Organic liquids	Changing biomedical and nuclear chemistry R&D activities	0.3	1	Treating or plan to treat onsite
Inorganic trash-3	Changing research and laboratory cleanup activities	50.7	50	Treating or plan to treat offsite
Lab packs with metals	Onsite R&D activities	0.8	1.5	Treating or plan to treat offsite
Metal chips and coolant	Depleted uranium turnings and chips from machining operations	3.2	unknown	Treatment options still being assessed
Contaminated soils	Waste generated from equipment maintenance	6.6	30	Treating or plan to treat onsite
Liquid mercury waste	Equipment maintenance	0.09	0.05	Treating or plan to treat offsite
Stabilized sludges and particulates	Sludges from tank bottoms and equipment cleanout that have been solidified/stabilized with cement	141.3	125	Treating or plan to treat onsite

TABLE H.2.6–1 *Mixed Low-Level Waste Streams at Lawrence Livermore National Laboratory* [Page 2 of 2]

Waste Description	Source Description	Inventory as of January 1995 (m^3)	Total Generation 1995-1999 Projection (m^3)	Treatment Option
Organic sludges and particulates	Sump waste, lab sink waste, dip tanks, etc.	1.2	5	Treating or plan to treat onsite
Other reactives	Contaminated equipment and containerized waste generated from onsite R&D activities	4.4	1	Treatment options still being assessed
Total		457.19	1,765	

Source: DOE 1995gg.

TABLE H.2.6–2. *Low-Level Waste and Mixed Low-Level Waste Treatment Capability at Lawrence Livermore National Laboratory* [Page 1 of 2]

Treatment Unit	Treatment Method	Input Capability	Output Capability	Total Capacity[a] (m^3/yr)	Comment
Building 513 shredding unit	Shredding, size reduction	Solid mixed LLW	Solid mixed LLW to Area 612 container storage units	5.5×10^6 kg/yr	RCRA Part A interim status; Closure date: 2009
Building 612 drum/container crushing unit	Size reduction	Solid mixed LLW	Solid mixed LLW (crushed empty drums) to Area 612 container storage unit	1.248×10^6 kg/yr	Permits: District Air; RCRA Part A interim status; Closure date: 2004
Area 514-1 cold vapor evaporation unit	Evaporation neutralization	Liquid mixed LLW	Liquid mixed LLW to Area 514 wastewater filtration	7,495	Permits: District Air; RCRA Part A interim status; Closure date: 2011
Area 514-1 centrifugation unit	Centrifugation separation	Liquid mixed LLW	Liquid mixed LLW to Area 514 wastewater filtration	7,495	Permits: District Air; RCRA Part A interim status; Closure date: 2011
Area 514 wastewater filtration unit	Filtration	Liquid mixed LLW	Solid mixed LLW to Area 612 container storage unit	3,731	Permits: RCRA Part A interim status; Closure date: 2004
Area 514 Wastewater Treatment Tank Farm	Liquid/solid separation, ion exchange, neutralization; leaching, oxidation, carbon adsorption, precipitation; deactivation, reduction, flocculation	Liquid mixed LLW	Liquid mixed LLW to Area 514 wastewater filtration	7,495	Permits: RCRA Part A interim status; Closure date: 2004
Area 514-1 carbon adsorption unit	Carbon adsorption, solvent extraction	Liquid mixed LLW	Liquid mixed LLW to Area 514 wastewater filtration	7,495	Permits: District Air; Closure date: 2011

TABLE H.2.6–2. *Low-Level Waste and Mixed Low-Level Waste Treatment Capability at Lawrence Livermore National Laboratory* [Page 2 of 2]

Treatment Unit	Treatment Method	Input Capability	Output Capability	Total Capacity[a] (m^3/yr)	Comment
Area 514-1/portable blending unit	Neutralization blending, flocculation	Liquid mixed LLW	Mixed LLW to Area 514 wastewater filtration	7,495	Permits: District Air; Closure date: 2011
Area 514-1/tank blending unit	Neutralization blending, flocculation	Liquid mixed LLW	Mixed LLW to Area 514 wastewater filtration	7,495	
Building 513 solidification unit	Solidification neutralization stabilization, immobilization	Liquid mixed LLW, solid mixed LLW	Solid mixed LLW to Area 612 container storage units	1,347	RCRA Part A interim status; Closure date: 2004
Building 612 size reduction unit	Size reduction, decontamination	Solid mixed LLW	Solid mixed LLW (size reduced) to Area 612 container storage units	1 x 10^6 kg/yr	RCRA Part A interim status; this unit replaces the size reduction unit in building 419. Closure date: 2011
Decontamination and Waste Treatment Facility	Will replace areas 514 and 612 using same type treatment methods	Liquid mixed LLW, solid mixed LLW; liquid LLW; solid LLW	Not determined	Not determined	The RCRA Part B permit application has not been submitted yet. This is a planned facility.

[a] For those facilities in use this is a normal operating capacity; whereas, for facilities under design or construction this is a design capacity. Schedules and capacities for facilities under design or construction are subject to changes based on the availability of funds, results of treatability studies, permit issuance, etc.

Source: DOE 1994n; LLNL 1996i:2.

TABLE H.2.6–3 *Low-Level Waste and Mixed Low-Level Waste Storage at Lawrence Livermore National Laboratory* [Page 1 of 2]

Storage Unit	Input Capability	Design Capacity[a] (m^3)	Comment
Receiving, segregation, and container storage (Area 612-4)	Liquid mixed LLW; solid mixed LLW	180.1	Container storage-RCRA Part A interim status; Closure date: 2009
Building 513 container storage unit	Solid mixed LLW	60	Container storage-RCRA Part A interim status; Closure date: 2004
Building 625 container storage unit	Liquid mixed LLW; solid mixed LLW	80.28	Container storage-RCRA Part A interim status; Closure date: 2009
Building 612 container storage unit	Liquid mixed LLW; solid mixed LLW	145.9	Container storage-RCRA Part A interim status; Closure date: 2009
Building 614 west cells container storage	Liquid mixed LLW; solid mixed LLW	2.55	Container storage-RCRA Part A interim status; Closure date: 2004
Area 514-2 container storage unit	Liquid mixed LLW; solid mixed LLW	39.4	Container storage-RCRA Part A interim status; Closure date: 2009

TABLE H-2.6—3 Low-Level Waste and Mixed Low-Level Waste Storage at Lawrence Livermore National Laboratory [Page 2 of 2]

Storage Unit	Input Capability	Design Capacity[a] (m^3)	Comment
Area 514-1 container storage unit	Liquid mixed LLW; solid mixed LLW	53.4	Container storage-RCRA Part A interim status; Closure date: 2009
Area 514 storage tank (514-R501 unit)	Liquid mixed LLW; liquid hazardous waste	84.5	Tank storage-RCRA Part A interim status; Closure date: 2004
Area 514-3 container storage unit	Liquid mixed LLW; solid mixed LLW	83.47	Container storage-RCRA Part A interim status; Closure date: 2009
Area 612 tank trailer storage unit	Liquid mixed LLW	19	Tank storage-RCRA Part A interim status; Closure date: 2009
Area 612-1 container storage unit	Solid mixed LLW	1,086.4	Container storage-RCRA Part A interim status; Closure date: 2004
Area 612-5 container storage unit	Solid mixed LLW	760.78	Container storage-RCRA Part A interim status; Closure date: 2004
Area 612-2 container storage unit	Liquid mixed LLW; solid mixed LLW	40	Container storage-RCRA Part A interim status; Closure date: 2009
Building 612 container storage unit	Liquid mixed LLW; solid mixed LLW; PCB TSCA mixed only	281.9	Container storage-RCRA Part A interim status; Closure date: 2014
Building 233 container storage unit	Liquid mixed LLW; solid mixed LLW	56.63	Container storage-RCRA Part A interim status; Closure date: 2023

[a] Schedules and capacities for facilities under design or construction are subject to changes based on the availability of funds, permit issuance, etc.
Source: DOE 1994k.

TABLE H.2.6–4 ***Hazardous Waste Quantities Shipped Offsite in 1994, Lawrence Livermore National Laboratory*** **[Page 1 of 2]**

Description	Number of Shipments Containing Description	Quantity (kg)	Estimated Volume[a] (m^3)
Articles, explosives, n.o.s.	6	12	<0.1
Barium nitrate	1	68	<0.1
Blue asbestos	8	321,113	214.1
Caustic alkali liquids, n.o.s.	17	3,828	3.8
Combustible liquid, n.o.s.	23	31,472	31.5
Compounds, cleaning liquid	3	91	<0.1
Corrosive solids, poisonous, n.o.s.	1	5	<0.1
Corrosive liquids, n.o.s.	41	11,755	11.8
Corrosive solids, n.o.s.	8	585	0.4
Corrosive liquids, oxidizing, n.o.s.	5	612	0.6
Corrosive liquids, poisonous, n.o.s.	3	151	0.2
Corrosive liquids, flammable, n.o.s.	3	37	<0.1
Environmentally hazardous substances, solid, n.o.s.	2	23,827	15.6
Environmentally hazardous substances, liquid, n.o.s.	1	438	0.4
Flammable solids, n.o.s.	10	977	0.7
Flammable liquids, corrosive, n.o.s.	12	302	0.3
Flammable liquids, n.o.s.	37	17,292	17.3
Flammable solids, poisonous, n.o.s.	1	12	<0.1
Flammable solids, corrosive, n.o.s.	1	32	<0.1
Flammable liquids, poisonous, n.o.s.	16	988	1.0
Hazardous waste, liquid	1	1,429	1.4
Hazardous waste, solid, n.o.s.	2	36,505	24.3
Hazardous waste, solid	3	37,025	24.7
Metal powders, flammable, n.o.s.	4	872	0.6
Nitrates, inorganic, n.o.s.	1	40	<0.1
Non-RCRA hazardous waste solid	53	287,054	191.4
Non-RCRA hazardous waste, liquid	60	62,121	62.1
Organochlorine pesticides, solid toxic, n.o.s.	1	8	<0.1
Oxidizing substances, liquid, corrosive, n.o.s.	2	211	0.2
Oxidizing substances, solid, corrosive, n.o.s.	2	16	<0.1
Oxidizing substances, solid, n.o.s.	7	149	0.1
Oxidizing substances, solid, poisonous, n.o.s.	5	65	<0.1
Oxidizing substances, liquid, n.o.s.	1	6	<0.1
Poisonous solids, corrosive, n.o.s.	1	6	<0.1
Poisonous liquids, corrosive, n.o.s.	4	288	0.3
Poisonous solids, n.o.s.	12	177	0.1
Poisonous liquids, n.o.s.	11	329	0.3
Polychlorinated biphenyls	20	21,779	14.5
Pyrophoric, liquids, n.o.s.	2	19	<0.1
Pyrophoric metals, n.o.s.	3	150	0.1
Pyrophoric solids, n.o.s.	1	15	<0.1

TABLE H.2.6–4 *Hazardous Waste Quantities Shipped Offsite in 1994, Lawrence Livermore National Laboratory* [Page 2 of 2]

Description	Number of Shipments Containing Description	Quantity (kg)	Estimated Volume[a] (m^3)
Substances, explosive, n.o.s.	1	8	<0.1
Substances which in contact with water emit flammable gases, liquid	5	39	<0.1
Substances which in contact with water emit flammable gases, solid	12	158	0.1

[a] For those shipments in which only a mass quantity was provided, a volume estimate was made based on density factors of 1,000 kg/m^3 for liquids and 1,500 kg/m^3 for solids.

Note: n.o.s. - not otherwise specified.

Source: DOE 1995h.

TABLE H.2.6–5. *Hazardous Waste Quantities Shipped Offsite in 1994, Lawrence Livermore National Laboratory Site 300*

Description	Number of Shipments Containing Description	Quantity (kg)	Estimated Volume[a] (m^3)
Combustible liquids, n.o.s.	5	30,030	30.0
Compounds, cleaning liquid	4	174	0.2
Corrosive liquids, n.o.s.	1	309	0.3
Non-RCRA hazardous waste liquid	10	34,036	34.0
Non-RCRA hazardous waste solid	8	28,316	18.9

[a] For those shipments in which only a mass quantity was provided, a volume estimate was made based on density factors of 1,000 kg/m^3 for liquids and 1,500 kg/m^3 for solids.

Note: n.o.s. - not otherwise specified.

Source: DOE 1995h.

Medical wastes from the Biomedical Sciences Division are autoclaved in Building 365 for sterilization before disposal as sanitary waste, except those biological wastes containing carcinogens. These wastes are inactivated chemically, or when this is not possible, disposed of in an appropriately labeled carcinogen/radioactive waste container. Sharps waste is sent to a commercial incinerator following sterilization.

Medical waste from Site 300 is generated at the Medical Facility, Building 877. These wastes are transported to LLNL where they are autoclaved at Building 365. The sterilized materials are then disposed of as sanitary waste.

Nonhazardous Waste. The Livermore Site discharges approximately 1.1 million liters per day (0.209 million gallons per day) of wastewater to the city of Livermore sewer system; this amount is less than 7 percent of the total flow to the city system (LLNL 1995d:6-1). This volume includes wastewater generated by Sandia National Laboratories (SNL) (Livermore). The wastewater contains sanitary sewage and industrial effluent from both LLNL and SNL and is discharged according to permit requirements and the city of Livermore Public Services Ordinance. The effluent is processed at the Livermore Water Reclamation Plant. As part of the Livermore-Amador Valley Wastewater Management Program, the treated sanitary wastewater is transported out of the valley through a pipeline and discharged into the San Francisco Bay. A small portion of the treated effluent from the Livermore Water Reclamation Plant is used for summer irrigation of the municipal golf course, which is next to the Livermore Water Reclamation Plant. Sludge from the treatment process is disposed of in sanitary landfills.

Administrative and engineering controls at the Livermore Site prevent potentially contaminated wastewater from being discharged directly to the sanitary sewer. Wastewater is collected and monitored at several different points from its generation to its release to the municipal collection system. LLNL completed construction of a diversion system to hold wastewater that is unacceptable for release to the Livermore Water Reclamation Plant. When an unacceptable discharge is detected by the monitoring system, the diversion system is automatically activated. Up to 775,000 L (205,000 gal) of potentially contaminated sewage can be held pending analysis to find the appropriate handling methods. The diverted effluent may be returned to the sanitary sewer, shipped for offsite disposal, or treated at LLNL's Hazardous Waste Management Facility.

Sanitary wastewater generated within the General Services Area at Site 300 is discharged to an onsite sewer lagoon. Other more remotely located buildings on Site 300 are serviced by septic systems and leach fields. Industrial wastewaters are contained in retention tanks and analyzed, and their proper disposition decided. These wastewaters may be shipped to LLNL for treatment and discharged to the sanitary sewer system or shipped directly to an offsite treatment and disposal facility. The nonhazardous rinsewaters from the HE machining, pressing, and formulation processes are disposed of by surface evaporation from two ponds.

LLNL does not have any onsite solid waste disposal facilities. After waste reduction and recycling, solid wastes are collected in dumpsters and other similar containers and transported to the Vasco Road Landfill for disposal. Solid waste generated at Site 300 is transported to the Corral Hollow Sanitary Landfill, approximately 6.44 km (4 mi) east of Site 300 on Corral Hollow Road. The San Joaquin County Public Works Department is currently evaluating alternatives for solid waste disposal, including expansion of the Corral Hollow Sanitary Landfill, siting of new landfills, and construction of a transfer station for disposal at another landfill.

The *California Integrated Waste Management Act* of 1989 mandates reductions in sanitary waste by counties. Sanitary waste must be reduced by at least 25 percent by 1995; the base year for this reduction is 1990. By 2000, the reduction must be 50 percent compared to the 1990 base. LLNL has already reduced this waste stream by over 40 percent from the 1990 base (LLNL 1995b:68).

H.2.7 Sandia National Laboratories

At the Albuquerque location of SNL, activities for R&D on national security and energy projects result in the generation and required management of TRU, low-level, mixed, hazardous, solid industrial, and sanitary wastes. SNL also has five spent nuclear fuel storage facilities: the Manzano Storage Structures, the Annular Core Research Reactor Facility, the Sandia Pulse Reactor Facility, the Hot Cell Facility,

and the Special Nuclear Materials Storage Facility. Past activities associated with nuclear weapon development, engineering, and testing at the site has resulted in environmental contamination. The principal sources included tests on weapons and weapon components, discharges of radioactive liquids and hazardous chemicals into the environment, oil spills, disposal of radioactive waste and hazardous chemicals in landfills, rocket launches, and burning of waste, including HE. The contaminated facilities range from reactors to scrap yards. SNL is not on the NPL for sites requiring environmental restoration in accordance with CERCLA and SARA. Because there is no spent nuclear fuel, HLW, or TRU waste associated with any of the proposed activities at SNL (nonnuclear fabrication and NIF), there will be no further discussion of these wastes at SNL in this appendix.

Pollution Prevention. A formal Waste Minimization and Pollution Prevention Awareness Program was initiated at SNL in 1989 to comply with EPA regulations and DOE orders. A Waste Minimization and Pollution Prevention Awareness Plan was completed in December 1991 and updated in December 1992 and May 1994. The plan specifies those activities and methods required to reduce the quantity and toxicity of wastes generated at the site.

Low-Level Waste. Onsite disposal of LLW at SNL was terminated in December 1988 as a result of a DOE order. Currently, all newly generated LLW is stored temporarily above ground at generator sites or in transportation containers at the inactive Technical Area III disposal site. In 1994, approximately 53 m^3 (69 yd^3) of LLW was accepted at the Technical Area III storage site (SNL 1995g:3-5). This waste consisted primarily of fission product and uranium-contaminated waste on a volumetric basis, and tritium-contaminated waste on an activity basis. The total liquid LLW and solid LLW generated in 1994 as packaged for treatment or storage was 0.912 m^3 (1.19 yd^3) and 53.3 m^3 (69.7 yd^3), respectively (SNL 1995f:7). All LLW packages were stored at the Technical Area III storage site and shipped for disposal at NTS.

Mixed Low-Level Waste. Unique tests and experimental programs at SNL have generated small volumes of a broad variety of mixed wastes. The total SNL liquid mixed LLW and solid mixed LLW generated in 1994 as packaged for treatment or storage was 0.007 m^3 (2 gal) and 1.94 m^3 (2.54yd^3), respectively (SNL 1995f:7).

SNL has submitted a Part B Permit application for a permit under RCRA, as amended, to allow for the storage and treatment of mixed radioactive and hazardous wastes. In August 1990, SNL submitted a RCRA Part A Permit application (interim status) to the State of New Mexico for the storage and limited treatment of mixed waste. In October 1992, a permitting strategy in the form of a Letter Agreement was submitted to the State of New Mexico for the SNL mixed waste Part B Permit application. In November 1992, SNL submitted a RCRA Part B Permit application for mixed waste. This application and the Part A application were amended in August 1993 and December 1994 submittals to the state. In January 1995, SNL submitted a revised mixed waste Part A and Part B Permit application to the New Mexico Environment Department. Treatments in the combined permit application now include compaction, stabilization/solidification, shredding/baling, decontamination/waste segregation, pH neutralization, encapsulation, chemical stripping/dissolution, destruction/extraction, chemical precipitation, amalgamation, ion exchange, reverse osmosis, demineralization, and hazard separation.

The Environmental Restoration Program at SNL is being performed under a RCRA Hazardous and Solid Waste Amendments Permit. The permit outlines the corrective action or cleanup processes at specific sites at SNL. The Environmental Restoration Program currently has no existing mixed waste in inventory. It is likely that some mixed waste will be generated during corrective action activities such as RCRA closures, RCRA facility investigations, corrective measures studies, and the implementation of selective corrective measures. The possible waste forms include soil and soil cuttings from drilling and excavation, excavated material such as discarded equipment, contaminated groundwater, decontamination liquid from the cleaning of drilling and sampling equipment, and personal protective equipment (SNL 1995c:6-2).

Although there are currently no operational onsite mixed LLW treatment facilities at SNL, plans are underway to develop some limited capabilities to ensure that mixed LLW can be treated to meet the land disposal restrictions treatment standards using existing technologies. The mixed waste site

treatment plan at SNL is heavily integrated with the work at other DOE sites that are tasked with developing mobile treatment units for use at multiple sites. This development involves proving-in new applications of technologies that are currently available but will require testing through treatability studies (SNL 1995c:iii).

Other waste streams, such as explosives, are being studied for onsite treatment by SNL because of its unique nature or handling requirements, or for development of treatment procedures that will facilitate eventual disposal, such as those required by the Nevada Operations Office for disposal at NTS. Offsite commercial treatment and disposal is an option for a small volume of scintillation waste and for waste that may not be treatable to meet the NTS Waste Acceptance Criteria (SNL 1995c:iii).

The Radioactive and Mixed Waste Management Facility at SNL Technical Area III was completed in 1990. Due to changes in regulations during construction, some facility upgrades are required before operations can begin. Once operational, mixed LLW will be treated in accordance with the strategies identified in the mixed waste Site Treatment Plan. This 557-m^2 (6,000-ft^2) facility will provide the means to open, treat, and repackage LLW and mixed LLW. The Radioactive and Mixed Waste Management Facility is expected to be operational in 1996 (SNL 1995g:3-5).

Currently, the Waste Operations Department operates the Technical Area III interim storage site. There are nine units described in the current RCRA Mixed Waste Part B Permit application, as amended in December 1994. The seven Manzano bunkers, the Radioactive and Mixed Waste Management Facility, and Building 6596 will be the main areas for mixed waste storage in the future. No additional storage capacity will be needed based on future generation rates. Most of these units are within the SNL technical areas although explosives are stored in the Manzano bunkers.

The mixed waste streams at SNL have been combined into 16 treatability groups, each with a preferred treatment option. Descriptions of the mixed waste treatability groups, volumes, preferred treatment option, and treatment site and facility are listed in table H.2.7–1. Treatment and storage facilities for LLW and mixed LLW are listed in tables H.2.7–2 and H.2.7–3.

Hazardous Waste. As a research facility, SNL generates a variety of hazardous wastes, many in relatively small quantities. All RCRA-regulated wastes generated (except mixed wastes) are transported offsite for disposal at RCRA-permitted treatment, storage, and disposal facilities. Chemical wastes generated by R&D activities are collected from generator locations, segregated according to DOT hazard class, and transported to the SNL RCRA-permitted Hazardous Waste Management Facility for storage. At the Hazardous Waste Management Facility, the wastes are consolidated and packaged according to DOT and EPA requirements. Packaged wastes are transported by DOT-certified carriers to RCRA-permitted treatment, storage, and disposal facilities or recyclers for final disposition.

During 1994, 691,700 kg (1,524,000 lb) of chemical wastes were managed by SNL's Chemical Waste Management Program, including 86,300 kg (190,300 lb) of RCRA-regulated hazardous waste and 605,000 kg (1,333,800 lb) of solid and recycled materials. A total of 29,780 packages were collected from SNL generators in 1994, packaged into 4,223 containers, and sent to treatment, storage, and disposal facilities and recyclers. The volume of RCRA hazardous waste processed in 1994 decreased from that reported in 1993; however, the quantity of solid and recycled material increases. The volume was influenced by the Kirtland Air Force Base solid waste landfill closure, Environmental Restoration Project remediation activities, and recycling operations (SNL 1995g:3-3).

SNL's Thermal Treatment Facility was issued a treatment permit in November 1994 by the New Mexico Environment Department to thermally treat residual explosives. In 1994, the Thermal Treatment Facility did not treat any residual explosives generated at SNL (SNL 1995g:3-3).

Hazardous waste quantities shipped offsite from SNL in 1994 are shown in table H.2.7–4. A summary of the hazardous waste treatment and storage facilities is shown in tables H.2.7–5 and H.2.7–6.

TABLE H.2.7–1.—*Mixed Low-Level Waste Streams at Sandia National Laboratories* [Page 1 of 2]

Treatability Group	Number of Waste Streams	Inventory as of May 1995 (m^3)	Projected Generation 1995 to 1999[a] (m^3)	Preferred Treatment Option	Treatment Site and Facility
Inorganic debris (with an explosive component): neutron generators, thermal batteries, and four small waste streams contaminated with energetic materials	6	2.7	<1	Deactivation	Onsite treatability study
Inorganic debris (with a water reactive constituent): lithium batteries and activated metallic sodium	2	0.04	<1	Deactivation	Onsite treatability study
Reactive metals: pyrophoric metal powders and finely divided metal powders	7	0.02	<1	Deactivation/ stabilization	Onsite treatability study
Elemental lead: lead shielding, bricks, pigs, boxes, and gasket	3	0.04	<1[b]	Macroencapsulate	Onsite using Pantex MTU
Aqueous liquids (corrosive): liquid acids or bases (pH < 2.1 or >12.4)	2	0.02	<1	Neutralization and stabilization	Onsite treatability study
Elemental mercury: tritium-contaminated mercury from temperature and altitude chambers; and tritium and uranium-238 contaminated mercury	1	0.0001	<1[c]	Amalgamate	Onsite using Pinellas MTU
Organic liquids I: hazardous scintillation waste and methanol	1	0.2	0[d]	Incineration	Offsite commercial facility
Organic debris (with organic contaminants): swipes, wipes, and personal protective equipment contaminated with solvents	32	28	1[e]	Thermal desorption	Onsite using GJPO MTU
Inorganic debris (with TCLP metals): cadmium sheets or rods, circuit boards with lead or silver solder, batteries, cables, electronic devices, weapons components	42	7	15[f]	Macroencapsulate	Onsite using Pantex MTU
Heterogeneous debris: contains both organic (combustible) and inorganic (noncombustible) debris	10	29	155[g]	No data provided	Onsite
Organic liquids II: vacuum pump oils, mixed nonhalogenated solvents, and a grinding sludge with trichloroethylene	1	2.7	<1	Hydrothermal processing	Onsite using LANL MTU (Treatability study at LANL)
Organic debris (with TCLP metals): swipes, wipes, personnel protection equipment, and trash contaminated with metals	3	0.6	<1	Macroencapsulate	Onsite using Pantex MTU
Oxidizers: uranyl perchlorates, uranyl nitrates, thorium nitrates, and uranium oxynitrate	3	0.01	<1	Deactivation	Onsite treatability study
Aqueous liquids (organic contaminants): corrosive liquid with methanol	1	0.01	159[g]	Evaporation, oxidation	Treatability study at GJPO

TABLE H.2.7–1.—*Mixed Low-Level Waste Streams at Sandia National Laboratories* [Page 2 of 2]

Treatability Group	Number of Waste Streams	Inventory as of May 1995 (m^3)	Projected Generation 1995 to 1999[a] (m^3)	Preferred Treatment Option	Treatment Site and Facility
Soils <50 percent debris	None	0	89[g]	No current inventory at SNL	No current inventory at SNL
Cyanide waste: potassium cyanide with uranium-238	None	0.001	0	Oxidation	Treatability study at LANL
Total	114	70.3411	<428	-	-

[a] The quantities are estimates only.
[b] The generation rate for lead solids may change significantly as the Lead Bank Program progresses.
[c] A small amount may be generated at SNL (Livermore), and managed under the SNL Mixed Waste Site Treatment Plan at the Albuquerque location.
[d] Because of the use of nonhazardous scintillation liquids, it is assumed that no organic liquid mixed waste will be generated in the next 5 years.
[e] The generation rate of organic debris may greatly decrease because of the reduction of hazardous solvents.
[f] It is assumed that the generation of inorganic debris will remain comparable to the current rate.
[g] From the Environmental Restoration Program.
Note: GJPO - Grand Junction Projects Office, Colorado; MTU - Mobile Treatment Unit; TCLP - Toxicity Characteristic Leaching Procedure.
Source: DOE 1995gg; SNL 1995c.

TABLE H.2.7–2.—*Low-Level Waste and Mixed Low-Level Waste Treatment Capability at Sandia National Laboratories*

Treatment Unit	Treatment Method	Input Capability	Output Capability	Total Capacity[a] (m^3/yr)	Comment
Radioactive and Mixed Waste Management Facility	Compaction, solidification, neutralization, precipitation, shredding, and stripping	Liquid and solid mixed LLW, solid LLW	Compacted various waste forms, gamma assay of waste packages, mixing and solidification of liquid wastes, performed bench scale treatment of waste, and segregated and repackaged various waste types	Bench scale	Status: under construction Date available: December 31, 1996 Termination date: January 1, 2020

[a] Schedules and capacities for facilities under design or construction are subject to changes based on the availability of funds and permit issuance.
Source: DOE 1994n; DOE 1995gg.

TABLE H.2.7–3.—*Low-Level Waste and Mixed Low-Level Waste Storage at Sandia National Laboratories*

Storage Unit	Input Capability	Design Capacity[a] (m^3)	Comment
Annular Core Research Reactor	Liquid and solid mixed LLW and liquid and solid LLW	29	Currently not storing waste. Part B submitted November 8, 1992; amended August 30, 1993. Date available: unknown. Termination date: January 1, 2020.
Area III Interim Storage Site	Liquid and solid mixed LLW and liquid and solid LLW	2,520	Operational; RCRA interim status: August 31, 1993. Termination date: April 1, 2020.
Building 819	Liquid and solid mixed TRU, TRU, mixed LLW, and LLW	259	Operational; RCRA Part B permit application submitted; amended August 30, 1993. Termination date: April 1, 2020.
Building 6502 High Bay	Liquid and solid mixed LLW	424	Nonoperational due to upgrades/major repairs Date available: January 1, 1995. RCRA interim status. Termination date: January 1, 2020.
Building 6596 High Bay Waste Storage Facility	Liquid and solid mixed TRU, TRU, mixed LLW, and LLW	916	Nonoperational due to upgrades/major repairs. Termination date: July 16, 2020.
Explosives Storage Igloo	Solid mixed LLW	57	Operational; RCRA interim status: August 31, 1993. Termination date: April 1, 2020.
Manzano Facility (7057)	Liquid and solid mixed TRU, TRU, mixed LLW, and LLW	183	Operational; RCRA Part B submitted November 8, 1992, and amended August 30, 1993. Termination date: unknown.
Manzano Facility (7045)	Liquid and solid mixed TRU, TRU, mixed LLW, and LLW	183	Operational; RCRA Part B submitted November 8, 1992, and amended August 30, 1993. Termination date: unknown.
Manzano Facility (7063)	Liquid and solid mixed TRU, TRU, mixed LLW, and LLW	235	Operational; RCRA Part B submitted November 8, 1992, and amended August 30, 1993. Termination date: unknown.
Manzano Facility (7078)	Liquid and solid mixed TRU, TRU, mixed LLW, and LLW	235	Operational; RCRA Part B submitted November 8, 1992, and amended August 30, 1993. Termination date: unknown.
Manzano Facility (7055)	Liquid and solid mixed TRU, TRU, mixed LLW, and LLW	235	Operational; RCRA Part B submitted November 8, 1992, and amended August 30, 1993. Termination date: unknown.
Manzano Facility (7118)	Liquid and solid mixed TRU, TRU, mixed LLW, and LLW	235	Operational; RCRA Part B permit application submitted November 8, 1992, and amended August 30, 1993. Termination date: unknown.
Sandia Pulse Reactor Dense Pac	Solid mixed LLW and solid LLW	31	Operational; RCRA interim status. Termination date: April 1, 2000.
Sandia Pulse Reactor Nova Vault	Solid and liquid mixed LLW and solid and liquid LLW	19	Operational; RCRA interim status. Termination date: April 1, 2020.

[a] Schedules and capacities for facilities under design or construction are subject to changes based on the availability of funds, permit issuance, etc.

Source: DOE 1994n.

TABLE H.2.7–4.—*Hazardous Waste Quantities Shipped Offsite in 1994, Sandia National Laboratories* **[Page 1 of 2]**

Description	Number of Shipments Containing Description	Quantity (kg)	Estimated Volume [a] (m^3)
Aluminum chloride, anhydrous	1	3	< 0.1
Articles, explosive, n.o.s.	7	51	< 0.1
Batteries, wet, filled with alkali	2	5,461	3.6
Cartridges, power device	1	< 1	< 0.1
Combustible liquid, n.o.s.	21	1,179	1.2
Compressed gases, flammable, n.o.s.	18	572	1.1
Compressed gases, flammable, toxic, n.o.s.	2	< 1	<1
Compressed gases, n.o.s.	6	132	0.3
Corrosive liquids, flammable, n.o.s.	2	13	< 0.1
Corrosive liquids, n.o.s.	72	11,266	11.3
Corrosive liquids, poisonous, n.o.s.	5	316	0.3
Corrosive solids, n.o.s.	16	564	0.4
Cyanide solutions	3	224	0.2
Detonators, electric	1	< 1	< 0.1
Environmentally hazardous substances, liquid, n.o.s.	5	1,193	1.2
Environmentally hazardous substances, solid, n.o.s.	3	303	0.2
Flammable liquids, corrosive, n.o.s.	15	403	0.4
Flammable liquids, n.o.s.	87	9,775	9.8
Flammable liquids, poisonous, n.o.s.	3	60	< 0.1
Flammable solids, n.o.s.	24	358	0.2
Formaldehyde solutions	1	184	0.2
Hazardous waste, liquid, n.o.s.	58	18,611	18.6
Hazardous waste, solid, n.o.s.	84	56,202	37.5
Iron pentacarbonyl	1	4	< 0.1
Mercuric cyanide, solid	1	7	< 0.1
Mercury	4	175	0.1
Mercury compounds, liquid, n.o.s.	1	4	< 0.1
Oil	1	780	0.8
Oxidizing substances, liquid, corrosive, n.o.s.	17	677	0.7
Oxidizing substances, liquid, poisonous, n.o.s.	1	5	< 0.1
Oxidizing substances, liquid, n.o.s.	10	89	< 0.1
Oxidizing substances, solid, n.o.s.	12	116	< 0.1
Paint	1	3	< 0.1
Perchloric acid	2	19	< 0.1

TABLE H.2.7-4.—*Hazardous Waste Quantities Shipped Offsite in 1994, Sandia National Laboratories* [Page 2 of 2]

Description	Number of Shipments Containing Description	Quantity (kg)	Estimated Volume [a] (m^3)
Phosphorus pentafluoride	1	< 1	< 0.1
Phosphorus pentasulfide	1	3	< 0.1
Poisonous liquids, n.o.s.	24	1,751	1.8
Poisonous solids, n.o.s.	19	212	0.1
Polychlorinated biphenyls	3	1281	0.9
Propellant explosive, solid	4	1385	0.9
Pyrophoric liquids, n.o.s.	1	< 1	< 0.1
Pyrophoric solids, n.o.s.	1	12	< 0.1
Rocket motors	2	190	0.1
Substances, explosive, n.o.s.	5	22	< 0.1
Substances that when put in contact with water emit flammable gases, liquid	6	35	< 0.1
Substances that when put in contact with water emit flammable gases, solid	26	517	0.3

[a] For those shipments in which only a mass quantity was provided, a volume estimate was made based on density factors of 500 kg/m^3 for gases, 1,000 kg/m^3 for liquids, and 1,500 kg/m^3 for solids.

Note: n.o.s. - not otherwise specified.

Source: DOE 1995h.

TABLE H.2.7–5.—*Hazardous Waste Treatment Capability at Sandia National Laboratories*

Treatment Unit	Treatment Method	Input Capability	Output Capability	Total Capacity[a] (m^3/yr)	Comment
Elementary Neutralization Unit; (870)	Neutralization	Liquid hazardous waste, corrosive	Neutralized wastewater	Data not available at this time	Nonoperational due to upgrades/major repairs
Thermal Treatment Facility	Open Burning	Liquid and solid hazardous waste and reactive waste (absorbent materials, filters, paper, and rags)	Gas, solid hazardous waste, listed, TCLP, carbon ash/possible silver contamination	Limited to 9.1 kg/campaign	Standby mode, RCRA interim status

[a] For those facilities in use, this is a normal operating capacity; whereas, for facilities under design or construction this is a design capacity. Schedules and capacities for facilities under design or construction are subject to changes based on the availability of funds, results of treatability studies, and permit issuance.

Source: DOE 1994n.

TABLE H.2.7–6.—*Hazardous Waste Storage Capability at Sandia National Laboratories*

Storage Unit	Input Capability	Design Capacity[a] (m^3)	Comment
PCB Storage Facility (958W)	Liquid and solid hazardous and sanitary waste (also sludge) and PCBs	10	Operational; date available: June 1, 1993
Hazardous Waste Management Facility (959)	Liquid and solid hazardous waste (also sludge and gas)	Data not available at this time	Operational; final RCRA Part B permit application submitted: July 31, 1992
Hazardous Waste Management Facility (958)	Liquid and solid hazardous waste (also sludge and gas)	Data not available at this time	Operational; final RCRA Part B permit application submitted: July 31, 1992

[a] Schedules and capacities for facilities under design or construction are subject to changes based on the availability of funds and permit issuance.

Source: DOE 1994n.

Nonhazardous Waste. SNL liquid sanitary waste is sent to municipal treatment facilities. SNL contains over 24 km (15 mi) of sewer lines interconnected with those of Kirtland Air Force Base. In June 1994, SNL activated the liquid effluent control system to retain process wastewater for radiological screening prior to disposal into the sanitary sewer. SNL's policy prohibits the disposal of radiological material above regulatory levels into the sanitary sewer system. Discharges by SNL to the publicly owned treatment works are regulated by the city of Albuquerque Public Works Department, Liquid Waste Division, under the authority of the city's Sewer Use and Wastewater Control Ordinance (SNL 1995g:6-1). Solid sanitary waste is collected and taken to the Albuquerque Sanitary Landfill on a regular basis. The total solid sanitary waste generated in 1994 as packaged for disposal was 13,600 t (14,990 tons) (SNL 1995f:7).

The classified waste landfill at SNL is a Class D landfill located in Technical Area III. The unit is an outdoor facility, 0.983 ha (2.43 acres) in size, used for the disposal of classified solid waste generated at SNL R&D facilities. The landfill currently operates under a notice of intent, submitted annually to the State of New Mexico Solid Waste Bureau. The industrial wastes (called classified solid waste) disposed of at this landfill originate from the classified reapplication yard. The waste stream consists of toner cartridges, computer tapes, crates and pallets, weapon components, and related hardware. The remaining capacity of this landfill is 9,635 m^3 (12,600 yd^3) (DOE 1994k).

H.2.8 Nevada Test Site

After underground nuclear tests, radioactive and hazardous materials were extracted and analyzed. These activities have resulted in the accumulation of low-level, hazardous, and mixed wastes that must be treated, stored, and disposed of. The *Site Book for Waste Management* (May 1994), the *Waste Management Plan for the Nevada Test Site* (February 1995), and the *NTS Site Treatment Plan* and Federal Facility Compliance Act Consent Order (March 1996) and the NTS EIS (Draft, December 1995) detail waste management activities at NTS.

Radioactive and hazardous wastes (according to the current definition of hazardous wastes) generated from past nuclear testing activities were disposed of at Areas 2, 3, 5, 6, 8, 9, 12, and 23. These were mixed wastes and LLW composed of debris, drilling mud, decontamination wastes, laboratory, and classified wastes. Areas 3 and 5 are still currently active for waste storage and disposal. Area 3 receives offsite and onsite bulk waste for disposal in subsidence craters. A RCRA closure plan has been submitted to the Nevada Division of Environmental Protection for this facility. The Radioactive Waste Management Site in the north of Area 5 contains LLW management units and receives packaged classified and unclassified LLW. It also has TRU wastes from LLNL in storage, and a hazardous waste accumulation site. The NTS is not currently accepting mixed wastes from any locations. Mixed waste could be accepted from defense related generators within the State of Nevada; however, there is no mixed waste ready for disposal that meets the land disposal restrictions of RCRA. Mixed waste has been disposed of from out-of-state generators, and this practice is planned for the future contingent upon approval and permitting (RCRA Part B) of future mixed waste disposal units and on actions resulting from the Record of Decision (ROD) on the Waste Management PEIS.

In the past, waste disposal at NTS was accomplished through landfills, underground injection and leachfields on NTS, and through offsite disposal of hazardous wastes. A goal of the NTS Environmental Restoration Project is to remove or immobilize hazardous substances, pollutants, and contaminants, while achieving compliance with environmental laws and regulations. Environmental restoration activities will be guided by the ROD from the NTS EIS and be in accordance with the Site Treatment Plan.

Pollution Prevention. The Nevada Operations Office is an active participant in DOE's National Waste Minimization and Pollution Prevention Program. A comprehensive Waste Minimization Plan for NTS was completed in 1991, which defines specific goals, methods, responsibilities, and achievements for organizations. A waste minimization organization promotes waste minimization and pollution prevention and assures compliance with DOE orders at NTS. A report on waste generation and waste minimization is published annually. DOE publishes site-wide plans and guidance, and each contractor

develops its own implementation plan. Plans and procedures have been developed, limiting the number and types of hazardous materials used on the site.

Since the initiation of the waste minimization program, several steam-cleaning operations have been eliminated, and half of the hazardous solvents used at NTS have been replaced with nonhazardous solvents. Recycling and reclamation activities have been established to reuse lead, silver, lubricating oil, and trichlorotrifluoroethane. Automatic decontamination equipment, recycling fabrication tool coolant systems, and continuous oil change and reburn systems have been placed in service to reduce hazardous waste generation. Closed loop effluent recycling for steam cleaning has eliminated the production of 17.8 million L (4.7 million gal) of wastewater annually and has reduced hazardous waste generation by 90 percent. Two solvent waste stills recycle 85 percent of all solvents and thinners used. Nonhazardous aqueous solution parts cleaners have eliminated the need for parts cleaning solvents.

The procurement of all materials is also reviewed for the opportunity to reduce the purchase of hazardous materials for NTS operations. In addition, an education and training program for all site personnel and for the surrounding community is helping to increase awareness of best practices and lessons learned in waste reduction.

Transuranic Waste. TRU and mixed TRU waste is stored at NTS on the TRU waste storage pad in Area 5. This waste was generated at LLNL and shipped to NTS between 1974 and 1990. All NTS TRU and mixed TRU waste is expected to be certified for disposal at WIPP in Carlsbad, NM, or another suitable repository should WIPP prove to be unsatisfactory. The Nevada Operations Office has the option to construct a TRU Waste Certification Building for breaching, sampling, and certifying containers of TRU waste to meet the WIPP Waste Acceptance Criteria which is expected to be finalized by June 1997 (NT DOE 1996b:4-61, 4-62). Other technologies, such as mobile characterization capabilities, are also being considered. This waste inventory consists of 612 m^3 (800 yd^3) of heterogeneous debris. The TRU waste is stored in the TRU Pad Cover Building on the TRU Waste Storage Pad to protect the containers from the environment. In addition, TRU and suspected TRU waste from weapons tests were emplaced in boreholes. Decisions to retrieve this waste or leave it in place will be based on performance assessments required by 40 CFR 191 and/or risk assessments required by CERCLA or RCRA. Table H.2.8–1 lists the mixed TRU waste storage units at NTS.

Low-Level Waste. Contaminated soils, created from past atmospheric nuclear weapons tests, occur at various locations on NTS. Some of this surface contamination has been and is planned to be removed and disposed of as waste. Although the debris from underground weapons tests remain underground, samples of this debris are brought to the surface for analysis and then must be disposed of as waste. The majority of LLW generated at NTS is disposed of in subsidence craters in Area 3. This area also receives substantial quantities of containerized bulk waste from other offsite DOE facilities. Some waste disposal units are being closed in this area, while others are being readied for future use. Area 5 receives low-level radioactive waste from both onsite and offsite generators. New disposal capacity is planned for this area, and the offsite generators will be required to meet the NTS Waste Acceptance Criteria (which includes periodic reviews by the Nevada Operations Office) to permit them to ship LLW for disposal at NTS.

Historically, the volume of waste received from offsite is approximately equal to or slightly greater than the volume of waste generated onsite. Recently onsite waste generation (other than environmental restoration waste) has declined due to cessation of nuclear testing. Offsite receipts currently dominate waste disposal activities at NTS. Remediation activities at NTS will produce waste streams that will have to be treated, stored, and disposed of. Offsite waste shipments must meet NTS Waste Acceptance Criteria that require that the waste be approved for disposal at NTS. Fifteen generators currently ship LLW to NTS, and an additional nine are applying for or are awaiting approval (NT DOE 1996c:4-61, 4-62). The LLW disposal capacity in use or planned at NTS is listed in table H.2.8–2.

Mixed Low-Level Waste. Mixed LLW is generated by DP-related support activities, environmental restoration activities, and activities supporting TRU waste disposal at WIPP or another suitable repository should the WIPP prove to be unacceptable. Wastes

TABLE H.2.8–1.—*Mixed Transuranic Waste Storage at Nevada Test Site*

Storage Unit	Input Capability	Total Area (m^2)	Comment
Asphalt storage pad (covered building)	Mixed TRU solid, mixed LLW	8,300 (1,995 in TRU pad cover building)	Available storage capacity on the TRU pad to be used for storage of future, onsite generated mixed LLW that does not meet RCRA land disposal restriction provisions.

Source: NT DOE 1996b.

TABLE H.2.8–2.—*Low-Level and Mixed Low-Level Waste Storage and Disposal at Nevada Test Site*

Disposal Unit	Input Capability	Total Capacity[a] (m^3)	Comment
Mixed waste, P03U management unit	Mixed LLW solid	118,908	Interim status. Onsite use only. RCRA Part A 1988. EA published, withdrawn. Will be considered in site-specific EIS.
LLW disposal, P04U	LLW solid, wood, metal, rubble, debris	66,946	Operational. Additional 616,300 m^3 capacity available for expansion
LLW disposal, P06U	LLW solid	27,002	Operational, reserved for future use
Classified shallow land burial, T02C	LLW solid, metal in approved containers	1,698	Operational, no remaining capacity
Shallow land burial, T03U	LLW solid, metal, debris, unclassified	7,086	Reserved for LLW disposal
Classified shallow land burial, T04C	LLW solid, metal in approved containers	1,518	Operational
Mixed waste storage pad	Mixed LLW solid	6,040[b]	Planned. RCRA Part B submitted in 1992
Bulk LLW disposal, U3AHAT	LLW solid, wood, metal, soil, biological	424,800	Operational

[a] Schedules and capacity for facilities under design or construction are subject to changes such as availability of funds and permit issuance.

[b] Estimated assuming no aisle space and containers stacked 2 m (6.6 ft) high.

Source: NT DOE 1996b; NT REECO 1994a.

were generated by the analytical activities supporting weapons tests and consisted of drilling muds and debris generated from tunnel reentry and rehabilitation. Additional wastes result from radiochemical analysis and decontamination of equipment and facilities used in sample extraction and analysis. NTS has received mixed wastes from other DOE sites and may receive additional waste in the future, pending the completion of the site treatment plans for all DOE sites and once proper permits are obtained. Mixed waste generated in the State of Nevada that meets the land disposal restrictions of RCRA can be disposed of in the Area 5 mixed waste disposal unit, Pit 3. Mixed waste not meeting land disposal restrictions can be stored on the TRU waste storage pad. A RCRA Part B permit application for a new mixed waste storage unit was submitted in January 1995.

Mixed LLW streams are being characterized to determine what technologies and capabilities are required for safe, environmentally sound, and compliant disposal. Construction of the Liquid Waste Treatment System, a central facility for treating liquid LLW and mixed LLW (contaminated effluents from environmental restoration and DP activities), has been funded and is being designed. Receiving/holding and evaporation reservoirs and associated mixed waste processes will be RCRA-permitted.

Table H.2.8–2 lists mixed LLW storage and disposal facilities at NTS. Table H.2.8–3 lists the mixed LLW streams inventory and 5-year projected generation at NTS. The total volume is 296 m^3 (388 yd^3), including a 20,425-kg (45,000-lb) empty spent shipping cask. Table H.2.8–3 lists mixed LLW waste streams at NTS.

Hazardous Waste. Hazardous wastes are generated from ongoing operations at NTS. Wastes consist of solvents, lubricants, fuel, lead, metals, and acids. Hazardous wastes are accumulated at various sites around NTS while they await shipment offsite to a RCRA-permitted facility. Over the next 5 years, additional satellite storage locations are planned. A separate accumulation site across the road from Area 5 is provided to avoid potential cross-contamination with radioactive waste. The generation of hazardous wastes at NTS is expected to decrease significantly because of the cessation of nuclear testing, the completion of environmental restoration activities, and the impact of waste minimization activities. Hazardous waste is stored on a 279-m^2 (3,000-ft^2) covered pad in Area 5 (NT REECO 1995a:33).

Nonhazardous Waste. Nonhazardous sanitary wastes are expected to be generated at the current rates for several years into the future, then decline due to the cessation of nuclear weapons testing. Recycling of paper, metals, glass, plastics, and cardboard has already resulted in some decreases in waste quantities.

TABLE H.2.8–3.—*Mixed Low-Level Waste Streams at Nevada Test Site*

Waste Matrix	Number of Waste Streams	Inventory Reported March 1996 (m^3)	Five-Year Projection	
			Number of Waste Streams	Total Generation
PCB contaminated soil	1	0.11	0	0
Lead contaminated soil	1	29.8	0	0
Bulk lead waste	4	2.49	0	0
Solvent sludge (Area 12)	1	0.11	0	0
Shipping cask	1	2.2	0	0
Treatability test facility solvent	1	0.21	0	0
Pico fluor	1	0	1	0.3
Analytical services solvent	1	<0.1	0	0
Cotter concentrate (A)	1	260	0	0
Cotter concentrate (B)	1	1.4	0	0

Source: NT DOE 1996b.

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